# The Foundry Trade Journal
## AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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## Forthcoming Event.

June 23.

*British Foundrymen's Association.*—Annual General Meeting, at Connaught Rooms, Great Queen St., London, W.C., at 3.30 p.m.

## NOTES AND COMMENTS.

### British Foundrymen's Association.

In the course of the present month the Council and members of this Association will meet in London for their annual review of progress and election of officers. There will doubtless be expressions of satisfaction (and not without cause) at the increase of membership and maintenance of Branch activity, despite the war and its claims. The foundry trade, of course, has not been depleted to nearly the extent that some other trades have been, and the men who have gone are not to any great extent the more responsible foundry workers, such as largely make up the Association. Allowing for this, however, it is obvious that the educational work of the Branches and its assistance to the industry is appreciated by the members, or the interest would not have been sustained during times of such severe stress.

While this is undoubtedly the case, it is well to guard against the feeling of complacent satisfaction that is usually born of contemplating a little progress. Without in the slightest detracting from the value of the Association's past work, we might, after according a hearty "well done!" justly turn to the vast amount of work in technical and educational progress which is still not done and not even contemplated. In the face of old prejudices it was perhaps the best policy for a relatively young Association to "ca' canny"; but recent events have set a new pace to technical developments. Old barriers have been broken down, new vistas opened, and the necessity of a bold and vigorous policy made very clear. Not for long can the past and still existing conditions of foundry knowledge, education, and technical co-operation be allowed to exist, unless the trade is to lag hopelessly at the tail-end of engineering; and it is for the British Foundrymen's Association to assert its influence, and take the lead in a definite move to advance the trade along new lines of development. Many things are possible to-day which were not possible in 1914, for at last the nation has awakened to the idea that the Government should render assistance in the progress of the nation's industries. So much can be done with Government authority and support that, however desirable, would fail if undertaken by individual firms. Research, experiment, training, and education are all essentials to progress, but are difficult to conduct unaided.

Many branches of the engineering trade already have established progressive movements, and are receiving useful support; but, as ever, there is a danger of the foundry being overlooked as a special department requiring separate consideration. It is here that the Association can prove its worth, by bringing forcibly before the Government and other authorities the claims of foundry workers. Unfortunately, its constitution does not give it just the same standing as an organised body of

technical experts. The British Foundrymen's Association is essentially first an educational institution, and, though it includes a large proportion of the most competent and highly-skilled men in the foundry and metallurgical world, it has not the same influence as a body composed of qualified professional or technical men, such as some other technical institutions are presumed to be. The Foundrymen's Association, therefore, requires to be particularly vigorous in its policy, in regard both to its own work and its claims on the attention of the Government. It should exhibit a thorough comprehension of the problems the trade has to face, and also a capacity to deal with them, given sufficient support in the right direction. It is not sufficient that individuals in its ranks evince progressive ideas and contribute energetically to technical advancement; the Association as a body, through its Council, should impress the country with its ability to represent faithfully the interests of the trade in technical matters. This can only be done by boldly setting itself to deal with at least some of the problems that face us every day, and producing some tangible contribution to foundry knowledge and technology. So far it has not one technical committee dealing with any of the numerous questions of foundry practice and science which call for consideration. In this it lags behind other technical associations, though there is no reason why it should. It is to be hoped that the near future will see this defect corrected.

A word of caution might here be given against the tendency, common to all such associations, of control to drift into the hands of coteries of men of similar ideas, to the detriment of progress and activity. Variety of ideas—even to the extent of antagonism—is essential to progress, and this can only be obtained by a policy of truly catholic co-operation among the members.

### Electric Power in Industry.

The Electric Power Supply Committee, appointed by the Board of Trade, under the chairmanship of the Hon. F. Huth Jackson, to consider what steps should be taken to ensure an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of such power for their development, have unanimously come to the following conclusions :—

1.—That the success of British industry after the war will depend upon the adoption of the most efficient methods and machinery, so as to reduce manufacturing costs as much as possible.

2.—That a highly important element in reducing costs will be the general extension of the use of electric power supplied at the lowest possible price, and it is by largely increasing the amount of power used in industry that the average output per head, and as a consequence the wages of the worker, can be raised.

3.—That the supply of electricity in a large number of small areas by separate authorities is incompatible with a technically sound system.

4.—That the interconnection of existing electric supply stations recommended by the Board of Trade in their letter of May 25, 1916, cannot alone meet the requirements of the situation.

5.—That a comprehensive system for the generation of electricity, and where necessary reorganising its supply, should be established as soon as possible.

It has been decided to invite representative associations throughout the country to give evidence before the Committee with regard to the best methods of giving effect to these conclusions.

## British Foundrymen's Association.

### Lancashire Branch.

The annual meeting of the Lancashire Branch was held on May 5, Mr. H. Sherburn presiding.

Mr. A. Harrison, hon. sec. and treasurer, in the course of his annual report, wrote that the past session had been the most successful in the history of the Branch, both in regard to attendances of members and the papers read at the ordinary meetings. During the twelve months 18 new members had been admitted and 6 had resigned, leaving 172 on the books. They had had to lament the death of the late Mr. Penlington, an ex-president, who had always taken a warm interest in the Branch, and whose place it would be hard to fill. The report and balance-sheet were unanimously adopted, on the motion of Mr. Whitham, seconded by Mr. W. H. Sherburn, who remarked that the high average of attendances at the meetings was especially gratifying, because the members had now better excuses for absence than in ordinary times.

The Chairman explained that it had been impossible, owing to the difficulty of travelling, to arrange for visits to works of interest during the past year.

After conversation, it was resolved that the Branch Council should in future consist of eight elected members, four to retire annually, in addition to the president, vice-presidents, hon. sec. and treasurer, and past presidents. Eleven members were nominated, and as the result of a ballot the following were declared elected :—Messrs. E. Barnes, C. Bickerton, S. Roe, Meadowcroft, A. Hill, J. Whitham, A. Sutcliffe and A. Harrison. Mr. A. L. Key was unanimously appointed president; Mr. R. Onions, senior vice-president; the election of junior being left to the Council; Mr. J. Hogg, hon. sec. and treasurer; Messrs. Nichols and Greenwich, auditors; and Messrs. J. Simpkiss and H. Sherburn, representatives on the General Council of the Association. A very cordial vote of thanks was carried by acclamation to Mr. Harrison for his many and valuable services to the Branch during the five years he had filled the office of hon. sec. and treasurer.

A hearty vote of thanks to the Chairman brought the proceedings to a close.

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**EFFICENCY OF AIR COMPRESSORS.** — Mr. H. E. MacCamy, in a recent thesis on air-compressor efficiency, states that there is only one condition under which a compressor can be worked whereby it can furnish the number of cubic feet of air which it was designed to produce, and this condition is the elimination of the moisture from the air. The usual way to effect this is to establish auxiliary receivers near the end of the line in which to condense and precipitate the water; but the water should have been removed from the air before it entered the high-pressure cylinder, or at least 90 per cent. of it. The power wasted in compressing steam in the high-pressure cylinder would be saved, and the oil used to lubricate the high-pressure cylinder would do its work instead of being carbonised. This carbon sediment finds its way through the receiver and pipe lines into the tools, requiring the user to soak them in kerosene or naphtha. Even the back pressure, so often found in the low-pressure cylinder, causing the low-pressure side of the compressor to give more trouble than the high-pressure side, is attributable to moisture.

# Modern Moulding Appliances.

Before a recent meeting of the Birmingham Branch of the British Foundrymen's Association, Mr. A. Carrick (Shipley) read a Paper on "The Modern Development of Moulding Machines." A brief abstract of this Paper was given in our issue of January last, but we reproduce it now more extensively, as follows :—

One can hardly introduce this question without briefly referring to what we may term the stepping stones to the machine, i.e., the "odd-side," follow-boards and plates, and it is surprising to what extent these very elementary means may be useful in improving both the quality of castings and in increasing the output. Probably the first stage in this development was the introduction of the joint-board, i.e., a flat board with planed face upon which the joint of a half pattern, or the face of a flat pattern, was laid.

This very simple method saved time in ramming a false part, and gave a better joint when rolled over, also saving time in joint making. From this it was a very easy step to making a hard part in sand or plaster-of-Paris for shaped joints, and in this way the odd-side came into existence, and with it the necessity for interchangeability in flasks or box parts. Following this came the time-honoured match plate with fitted dowels and dowel-holes for the flasks, and carrying a portion of the pattern attached like a medallion. This system of plate moulding is very popular in the light casting trade to-day, and splendid results are obtained both in the quality of castings and in the cost of production.

These early innovations were in themselves, and may be truly designated, a form of machine moulding, which could be adopted with very great advantage in very many foundries to-day. The author cannot give with any degree of accuracy the exact date or even period of the introduction of moulding machines in this country, but as far back as the year 1800 an English patent was granted for moulding screws, the patterns of which were backed out of the sand by lead screws of the same pitch. This was simply a pattern-drawing machine of a rather ingenious construction, and so far as we are aware the English patent records do not touch again upon machine moulding until 1839, when a very similar patent appeared. Machines for moulding gears and pipes also appear in the first half of the nineteenth century, but it is only within the last 25 or 30 years that moulding machines have been used to any great extent in this country.

Moulding machines, both hand and power, may be classed under four heads: (1) Machines that only ram the mould; (2) machines which draw the pattern; (3) machines that both ram the mould and draw the pattern; and (4) machines in which every operation is mechanical, viz., sand-filling, ramming, pattern-drawing and conveying finished mould away.

The first and second were the most popular machines in what we may term modern machine moulding, and although these machines are very simple pieces of mechanism compared with the modern machine tool or high-speed engine, they accomplished well nigh as great a revolution in the foundry as the latter did in the machine shop, and there can be no doubt that in some foundries wonderful results were obtained in both quantity and quality of castings by the aid of these very simple devices. And those foundries that adopted them forged ahead, and undoubtedly enjoyed a greater measure of prosperity than those who were content with the methods of hand moulding. It is hardly necessary to describe in detail the operations on these simple machines, or to endeavour to give a list of the kind of work that can be done on them. The hand press, or squeezer as it is more popularly known, is exceedingly serviceable, and is largely used for small light work in iron and brass foundries. It consists simply of a strong table mounted on two stands to which is attached a press head, generally operated by a side lever. A board or hard part is placed on the table, flask put in position and filled with sand, press head swung over and sand pressed, all other operations being accomplished in the ordinary way; and there is undoubtedly a large scope for these machines to-day, and there are hundreds of foundries in this country where they might be adopted with advantage.

Following the hand press we come to the hand turnover machine, which has enjoyed a larger measure of popularity in this country than any other type of machine. The general principles of moulding in this type may be briefly described as follows :—Plates, boards, plaster blocks or any kind of hard part may be used. These are attached to the top side of a revolving table by bolts, clips or screws. A bottom box is placed over it and rammed by hand. It is then clamped to the master part, the table reversed and the mould left suspended; the lower platform is then raised by means of side lever until it is pressed firmly against the back of the box; the clamps securing the box to the master part are released and the platform lowered steadily, the mould descending with it away from the patterns, the top table being rapped with mallet during the drawing process to ensure a free draw. The whole of these operations do not take more than 20 or 30 seconds in the hands of an expert operator. The resulting mould should not require any finishing, and if there are no cores to insert, should be ready to receive the top part.

It will be observed that both the sand filling and ramming is exactly the same as in hand-moulding, and the operations saved (as against ordinary moulding) are joint-making, runner-cutting and finishing. Yet it is astonishing what can be saved by these latter operations. Scores of illustrations might be given where the production has been increased 100, 200 and even 300 per cent. with the same labour cost by taking jobs from the bench or floor and putting them on these machines. The cost of mounting the work sometimes only amounts to a few shillings; but the saving in labour is not the only advantage; there is greater uniformity in the finished casting, and a much longer life to the pattern. There is scarcely any limit to the work that can be made on these machines, not only plain flat blocks, but very intricate castings that on the floor would require highly-skilled moulders. Nor are they limited to small work; there are machines of this type working in this country making castings weighing over a ton.

These machines are very simple pieces of mechanism, cheap, with very little to get out of order; and even with very rough usage they will last a long time. They can be used with advan-

tage in the jobbing shop as well as for repetition work, and are useful for core making as well as moulding.

Before leaving hand-machine moulding I should like briefly to refer to two other types, one English and one American. The English machine is the hand-press and pattern-drawing machine made by the Britannia Foundry Company, Coventry. In this machine the press is operated with a large star handle coupled on to an internal wheel and two pinions. By this means a great amount of power can be got. The pattern-drawing is accomplished by a side lever, which operates two spindles on which are carried a plate with a rod at each of the four corners. These can be adjusted to suit different sizes of boxes and plates, and instead of the pattern being drawn from the mould, by a motion of the side lever the four rods catch the four corners of the moulding box and lift the mould from the pattern.

The American machine is the "Pridmore"—probably the most popular hand-ramming machine in the States. Its construction is simple and substantial, consisting of a frame standing on the floor, and carrying the stripping plate, a yoke or plunger working up and down in the frame and carrying the patterns and one or more sets of cranks and pitmans for dropping or raising the yoke with the pattern. Adjustments are provided for shortening or lengthening the draw, for raising or lowering the patterns relative to the stripping plate and for taking up the wear on the ways and crank pins. Although these machines are primarily stripping-plate machines, so accurate is the drawing apparatus that the author has made jobs 8 in. and 9 in. deep on them without using a stripping plate.

The machines thus far referred to are largely operated by unskilled or semi-skilled labour, and one of the principal qualifications of these men is physical strength. There are few men in this or any other country doing harder manual labour than these moulding-machine operators.

Nearly all the power machines on the market are either hydraulic or compressed air, the latter being both most serviceable and popular. Dealing first with the hydraulic machines, an admirable example is the French machine by Bonvillian & Ronceray. This is intended primarily for repetition work, and stripping plates are largely used, the makers having perfected a system of their own for making stripping plates and stools, which can be accomplished largely by the moulder himself, very little fitter's work being required, however intricate the casting may be.

Compressed-air machines without doubt are the most popular power machines. The Americans make every class of casting, from a few ounces to 20 tons in weight, on these machines. Following the same lines with the compressed-air machines as with the hand machines, we start with the power squeezer adapted to the same class of work as the hand squeezer, which saves the work of ramming, but puts upon the operator the work of squeezing. In this case the machine does the squeezing, and consequently the operator is less fatigued and can work faster. Moreover, greater uniformity in pressure can be had with the power squeezer, without putting any undue strain on the man.

### Rammers and Pattern-drawers.

The development from the power squeezer (or from ramming only) to both ramming and pattern drawing, is a very easy stage, but marks a great advance. A good example of the type is the Tabor power squeezing split-pattern machine. This machine is particularly adapted to making moulds from symmetrical patterns that can be split through the centre, or for flat-back work. Patterns adapted to this machine are not, however, limited to the two classes mentioned, as any pattern that can be split on a true plane may be moulded on it. With symmetrical patterns but a single plate of patterns is necessary, as the cope and drag are moulded from a double set of half patterns, the impression of the right-hand set in the drag matching those of the left-hand set in the cope, and vice-versa. In operating this machine the half flask is put in position over the pins in the flask frame of the machine and filled with sand. The yoke is now drawn forward and pressure applied to the mould by pressing down the operating lever until the pressure gauge indicates that the sand has been squeezed to the proper density, then the yoke is thrown back, sand strickled off, and the pattern drawing is accomplished by lifting the same lever, which also starts the vibrator and raises the mould, the frame dropping automatically back to its place immediately the mould is lifted off.

While these machines under ordinary conditions do not require a stripping plate, it is possible to fasten one to the flask frame to insure a perfect draw in the case of very intricate work; and the author has used both stripping plates and stools on this class of machine.

### Jar-ramming Machines.

So far, in both hand and power machines, we have dealt only with comparatively small work, but with the introduction of jar or jolt-ramming machines there is a much wider range. Almost any kind of mould, whatever may be its shape or size, can be dealt with, and not only does it do away with some of the hard labour of the moulder (a feature which ought to recommend itself to both workman and employer) but it does it both more efficiently and in infinitely less time. Although jar-ramming machines are probably the latest development in foundry machines, jar-ramming is in all probability as old as the trade itself, and there are few moulders who have not in their first apprentice days made small cores by jarring the core-box on the bench to accomplish the ramming.

What is known as the plain jar-ramming machine consists of a huge plunger base which rests upon a bed of concrete of given dimensions to form an anvil. On this plunger base is a bumper frame (inside of which is the plunger and cylinder) which carries the jolting table. In some machines the bumper frame and jolt table are in one piece. Generally the stroke is of minimum length, and is adjusted to hard or light blows as desired by a back pressure valve, or by a variable stroke, which can be adjusted to the conditions required. It is essentially a sand-packing machine, the packing of the sand resulting from the impact between the table on which the mould is carried and the anvil on which it drops. To avoid unnecessary intensity in the blow struck by the table upon its anvil, a few layers of leather or other non-resilient material are introduced as a cushion. These reduce the wear and tear and noise without having any material effect upon the action of the machine or sand. A machine of this type can be successfully used for ramming moulds for either iron, steel, or brass, and will ram any mould, large or small, in a minute or even less time.

The saving to be effected by its use on large work is practically the whole of the ramming time by hand. But there is another special advantage over hand-ramming: the sand is packed as it should be, densest at the surface of the pattern and of decreasing density above, thus favouring the escape of gases when the mould is poured.

We have found it possible to do away with a lot of venting, while scabbing is nearly unknown, since we introduced jolt-ramming. It is not, however, every pattern that can be rammed in this way, and care must always be taken to avoid projections on the pattern which interfere with the proper flow of sand. This sometimes necessitates the use of a core not required for hand-ramming, but the patterns when mounted for jarring require fewer repairs, and the cost of adaptation to the jarring process is soon recovered. The practice adopted by the author is to have the patterns mounted on a board. If it is a repetition job a proper board forming the joint and following the contour of the patterns is made. If, however, only a few are required, an ordinary rough follow-board is used. The board pattern and flask are put on the machine table and filled with sand about 3 or 4 ins. above the bottom part by a labourer. The machine operator then opens the valve and jolts, finishing off with flat rammer and doing any necessary venting. The mould is then handed over to the floor-moulder to be finished and got ready for pouring. In cases where the joint is not formed on the board, the cope is rammed by hand. Where a proper board is used the cope can be jarred like the drag. A machine operator and one labourer who are on piece-work are able to keep a gang of three or four moulders finishing. Thus far our experience has been that this gang of two moulders and machine operator and one labourer have done the work of about six or seven floor-moulders working under ordinary conditions.

The shockless jar-ramming machine accomplishes exactly the same work for the moulder as the plain machine, but it is claimed by the makers that all ground shock is eliminated. Further, that only a few inches of concrete is necessary for the foundation, as distinct from the plain jar-ramming machine, which delivers the entire blow upon the foundation.

Passing to the next step in the development of these machines, or the adding of pattern-drawing apparatus, practically the same devices for pattern drawing have been utilised as additions to the jar-ramming that are used in hand-ramming machines and other power machines, viz., direct lifting of mould from pattern, drawing through stripping plate and turn-over, the latter again being the most popular. The addition of these drawing mechanisms gives a fairly complicated machine, but while it will be readily admitted that great adantage is to be got from these machines in highly specialised and repetition work, there is plenty of scope for them in the average foundry. Not only must care and thought be used in selecting the right machines for the work, but equal care and infinitely more thought should be used in making the necessary tackle. It is not always necessary to put down very expensive tackle in order to make the machines a success. One should be guided by the class of work, number required, etc., and many times it will be found that the outlay will be very little greater than for floor-moulding. It is not always necessary to be making work by the hundred or thousand to use the machine successfully; many times where only very small quantities are required it can be done better and cheaper on the machine, and the tackle that is required to do this ought to be in every foundry whether they have a machine or not, or whether they are on jobbing or repetition work—I mean a dozen or two moulding boxes that are interchangeable, with a couple of planed plates and boards and a few loose runners or gates of different sizes. These are very elementary things that neither involve any great amount of thought or expense, and may be the means of effecting considerable saving, as well as forming a stepping stone to greater things in machine moulding. Of course, by far the greatest advantage to be derived from the machine is in repetition work, and there is little doubt that the tendency in the future will be to specialise, and consequently there will be greater scope for machine moulding. In such cases where there is that tendency to specialise and where it is known that the work will be made on the moulding machine, the foundry manager ought to be consulted before the work leaves the drawing office. Many times alterations can be made that will greatly facilitate the work being made on the machine, without in any way impairing its effectiveness for the work it has to do.

### Discussion.

PROF. TURNER said that there was no doubt that the proper development of the foundry was a matter of national importance. It was desirable to have light and airy buildings instead of the dark and cramped places they often saw used for foundries, to have proper access to the different departments, proper appliances for handling, proper melting appliances, and particularly, as they had learnt that evening, the most improved moulding appliances. All these things were necessary to the success of the foundry industry.

MR. GEORGE BUCHANAN (Manchester) said that, as far as his experience went, it would be a very difficult thing in the majority of jobbing foundries to instal moulding machines of any kind, because they had not interchangeable moulding boxes or pattern plates of any sort. He had known many instances of moulding machines being purchased on the representation of the makers without due consideration of what else was involved, with the result that the machines, after being placed in the foundry, remained unused.

MR. H. PEMBERTON (Derby) said that in the foundry with which he was connected they had at one time what he believed was the largest jolt-ramming machine. It had a 4 ft. by 3 ft. table, and afterwards one was installed with a table 6 ft. sq. with a 20-in. cylinder. A great deal of good work could be done with moulding machines, power presses, and jolters. He did not think hydraulic machines had come to stay. They would not live up against the jolt machine. The prejudice against moulding machines on the part of moulders was due, he thought, somewhat to the makers of moulding machines claiming greater capacities than the machines had been capable of giving. If a little more consideration were given to the man who worked the machine they would have less difficulty in getting labour-saving devices adopted in the foundry. He had had a job done with jolt-ramming machines where the mould weighed 10 tons, and this had taken a great deal of the heavy labour from the moulder.

Mr. A. P. Smith (Britannia Foundry, Coventry) said that he would advise anybody who thought of going in for moulding machines to go to foundries where machines were used and see them on the daily work done at ordinary competitive prices. He had been over Mr. Carrick's foundry and was very much impressed by the very thorough manner in which everything was done there. Mr. Carrick was carrying out all classes of work from very light to very heavy on machines, and he (Mr. Smith) did not think he had seen that in any other foundry. The great thing was to get someone interested in the machine, and unless there was someone, manager or foreman, who took that interest the machine was not likely to be a success. A machine, whether it cost £10 or hundreds of pounds, would only ram the sand round the pattern and extract the pattern without damaging the mould. The great thing was to have a proper pattern plate, and it required a clever man to know how to fix certain jobs on the machine. In most cases the success of the machine depended upon the foundry engineer or a skilled patternmaker.

Mr. A. Leigh (Manchester), speaking from the point of view of the manufacturers of moulding machines, said that one gentleman spoke about the moulding machine not being altogether suitable for jobbing work. He would like to say in reply that they had machines at the present time being used in purely jobbing work, the patterns being put on the machine without any fixing at all. Mr. Carrick told them about one machine that he had being bedded down on a 10-ft. thickness of concrete. He thought that if Mr. Carrick would examine that machine again he would find that the concrete bed was not anything like so deep as 10 ft. A certain firm in Scotland had a very similar machine to the one referred to by Mr. Carrick. They had a river running through their works which overflowed periodically and under their foundry they had shifting sand, and though the foundation as shown on the maker's drawing was not over a foot deep absolutely no trouble had been experienced. With regard to undercutting of the pattern, he might add that in certain cases one could jolt satisfactorily with a slightly undercut pattern by arranging the boxes in a certain manner.

Mr. B. Hird (Peterborough) said that in his present foundry he had a 6 ft. sq. jolt-ramming machine and was just putting in another. He would like to ask whether anyone could give him any information as to ramming of flat tops on the bumper; also as to the best way of dealing with copes so as to prevent soft spots coming under the bar. He had tried very tapering bars, but even with those there seemed to be a certain amount of hanging to the side of the bar giving a soft place under the bar. He had got over that in smaller-sized boxes, about 18 in. wide and 3 ft. long, by having the bars about 6 in. apart and standing out from the box side 3 to 4 in. as was sometimes done in making middle parts in the ordinary way; and using that for the top, and then plating it to prevent the top from bursting up when the iron was poured into the mould. These boxes answered very well as there were no bars over the pattern. But with ordinary top parts he had had trouble in ramming flat tops. He had tried with boxes 7 ft. by 4 ft. sq., and 8 in. deep, and with a box 2 ft. 8 in. and 6 in. deep. He could get one or two, and then two or three would drop out, so that he never could be certain of getting them right. He was not disparaging the machine at all because it was not a big job after all to ram up the top. They were making a large number of moulds with these machines and found a great saving in labour. Even when the moulder rammed the flat top they got two or three times the former output. One would think it the simplest thing in the world to ram up a flat top on the bumper but they had not been successful.

Mr. Carrick: Have you tried fastening the box to the board?

Mr. Hird said that he had, but he could get the best results by putting the top box on the table itself without any fastening. He had gaggered them, but that did not appear to be necessary. If the bars which they used came down within half an inch of the box edge it was quite near enough to carry the sand. He would also like to know if Mr. Carrick experienced any inconvenience with the pattern board overhanging the "bumper" table? Did he find any difficulty through its moving about on the table and having to shift it back again before it had got sufficient ramming?

Mr. A. Wardle (Coventry) thought that there was a limit to the amount of under-ramming one could get on the jar-ramming machine; but the jar-ramming machine would do it to some extent, he thought about 45 degrees. For any work beyond that angle they would have to put in loose sand and jar a second time.

Mr. F. J. Cook said that where there were very few articles of one design to be made it was a great question whether it would pay to instal machines, because the cost of the pattern plates might be more than the amount that would be saved in the actual moulding. Obviously, it was not economical to put everything on a moulding machine, and it required very great care to select the type of machine which it would pay to have. If there were very large quantities no doubt a stripping-plate machine was the right thing to have, whilst for general jobs he quite agreed that the scope of the jar-ramming machine was practically unlimited.

Mr. Pemberton, referring to Mr. Hird's question as to the ramming of the flat-topped part, said that in his foundry they had for some time had a great deal of difficulty in the ramming of a flat top on a jar-ramming machine. The thing was not so simple as it looked. He tried bolting the boxes down, but that was not a success. They got over the difficulty by riddling or putting a certain amount of sand on to the top of a plate and then bedding the box on to this. He found that the cause of the top part dropping was that the sand jarred away from the box bars leaving a hollow space so that there was nothing for the surrounding sand to adhere to.

Mr. Carrick, in reply, referred to the question of labour on moulding machines. On their jolt-ramming machine they had one skilled and one unskilled man—he was speaking of the very large machines making jobs up to 2 tons, that was to say, plain jobs. The work was taken off and put on the moulding floor for finishing purposes. Of course, they did not get anything like such hard work as with hand ramming, and this was considerably better for the moulder. Dealing with Mr. Hird's question as to ramming of cope parts, he would say that the biggest job they had undertaken in his foundry was the casting of lathe-bed gantries. They did not have the same

difficulty there as one had with a job of greater width. But he thought that the method suggested by Mr. Pemberton was a very good one, namely, riddle a bit of sand over the pattern before putting on top part and knock it down. But the practice followed in his foundry—and they were making milling-machine bodies weighing over 2 tons, was to cover them just in the ordinary way, making the box bars with plenty of taper. They had made hundreds of fairly good-sized moulds without any dropping of the tops that were perfectly flat. They made a great number of flat boxes about 3 ft. square but not of the size Mr. Hird mentioned. In the case of a cope of 6 or 8 in. deep the mould was jolt rammed to within a few inches of the top, and then the peg rammer used for the last few inches. They had made three- and four-part jobs on that machine. They rammed the middle part level, then put on loose part, and jolted the second part without any difficulty at all. It was a question of having the first part jolted sufficiently hard and using a certain amount of judgment in jolting and making the joints.

### Discussion at Lancashire Branch.

Mr. Kenyon remarked that Mr. Carrick was speaking from his own experience, and telling them things which he had actually proved. He would add to the debt they were under if he would answer a few questions. Referring to the Tabor machine, the author had said it was quite fair to estimate an output of 80 to 100 boxes a day. At his (Mr. Kenyon's) works with the ordinary Jobson turnover machine a man could do 80 boxes a day. On these figures there was no great advantage. Then if the Tabor were installed the trade union might say: "The box is a certain size, and we shall want the same price for it whether you make it on the Tabor or on the Jobson." During the last twelve months they had had a little experience with the Pridmore. The conclusion they came to was that if they used iron flasks, such as were used regularly on the Pridmore, they could get much more economical results than by using the ordinary wooden flasks, simply from the fact that they could fill the iron box very close to the edges, but with the wooden box they had to keep a considerable distance away. When there was a fixed price per box, irrespective of contents, this became a serious matter. Would the jolt ramming give satisfactory results on light work? He could quite see that with some of the things illustrated it would save a great amount of ramming, but when they came to deal with light boxes, say, 18 in. by 10 in., would they get better results from jolt-ramming than from ordinary ramming with the Jobson turnover machine?

Mr. Cordingley said he could bear out from actual experience what Mr. Carrick had said about the value of jolt-ramming. The moulders did not object to it; their labour was not so hard, and it was done more quickly. The advantages to be derived from the introduction of new methods and new machines must not be looked at from the point of view of the employer only. The men ought to share by increased comfort and better working conditions.

Mr. Hogg asked whether the jolt-ramming machine was good for light work as well as for heavy work. He knew cases where it had been a failure. Perhaps the reason was that more education was needed.

Mr. H. Sherburn said Mr. Carrick did not touch upon one phase of the subject. How were they to induce the people who controlled foundries to allow the necessary capital expenditure? It was of little use to convince the foundrymen, whether they were in charge or subordinates, that certain things were good, if the management would not put down the money. Education must extend to the financial side as well as the technical side. The difficulty experienced with the split-pattern air-operated type of machine had been the liability for the castings produced to be slightly out of alignment after the machine had been in operation for some time. This was due to the fact that the pattern plate rested in one frame whilst the box or flask was carried on an outer frame. Thus a possibility of the box and plate getting out of alignment was presented; whereas if the box or flask engaged the plate itself, as was the practice in ordinary plate moulding, the possibility of faulty castings in this respect would be directly traced to excessive clearance in the guides between the plate and the box, provided, of course, that the plate patterns were accurately made, which was a first essential. To work the machines described by Mr. Carrick under moulding-shop conditions it was imperative to have men who had besides mechanical skill practical foundry experience.

Mr. Sdkiss said that when using squeezer machines some years ago he noticed that one difficulty was the depth of the squeeze; they had to part-ram before they got the full extent of the squeezer. If they filled the flask and used the squeezer immediately they got soft places. That was with a hand machine.

Mr. Carrick, in replying, said it was not an uncommon thing with a Tabor or Mumford machine to do 200 to 300 boxes in a day with small light work. In his Paper he referred to much heavier work. The class of work which Mr. Kenyon described as being done by the Jobson at the rate of 80 boxes a day could be dealt with by the Tabor and Mumford without any difficulty at the rate of 150 boxes a day—on the split-pattern power machine. He admitted the existence of the difficulty described by Mr. Sherburn, but it had been got over very well, and tens of thousands of castings had been made with very little twist on them. Mr. Hogge had asked a very important question about the suitability of the jolt-ramming machine for light boxes. He thought the press machine was far better for such work. In the Paper he particularly emphasised the point that care and thought must be used in selecting the right machine, and probably the reason for Mr. Hogge's unsatisfactory experience was that the job was not a suitable one for the jolt-ramming machine. With light work it was not advisable to have a lot of loose pieces where there was jolt-ramming, but it was quite possible to eliminate them in many cases by a little judgment in the pattern-making and designing. Mr. Sherburn had referred to the difficulty of inducing employers to lay out money in providing machinery. For years the employers had grumbled at the backwardness of the moulder; if they refused now, when these improvements were brought to their notice, to introduce them, so much the worse for them. Of course, it was necessary to exercise some judgment in the matter. There was scope for both unskilled and highly skilled men on moulding machines: it was simply a question of drawing the line of demarcation. Some jobs could be done quite well by semi-skilled or unskilled men; on the other hand, with very intricate and heavy work it was best to put good moulders on.

# Notes from the Brass Foundry.*

By H. G. Barrett.

The demands by engineers in the past for bronze, gun-metal and brass were in many instances prompted more by a name than by a knowledge of which would fulfil the mechanical requirements. To-day, however, there is an increasing demand for alloys of definite chemical composition and mechanical properties, the mechanical requirements being strength, malleability, or hardness in a general way. Many non-ferrous alloys to fulfil special requirements have been made available by extensive research, and there are now placed before foundrymen metals and alloys of a decided standard and in convenient form for immediate use. Metals and alloys should be purchased with a guaranteed analysis or at least from a reliable firm. Many foundries are now using gun-metal ingots for special work in preference to alloying the metals in the foundry, using no scrap but their own returns.

### Meta.

The base of bronze, gun-metal and brass is copper, which has a melting point of about 1,050 deg. C. It is one of the best conductors of heat, highly malleable, ductile and tenacious. When selecting copper ingots the following is worth noting:—Under-poled ingots have a longitudinal furrow on the upper surface; over-poled ingots have a longitudinal ridge; good, tough copper ingots have no ridge or furrow. There will be a slight depression due to contraction, but the surface will be comparatively smooth. Under-poled and over-poled copper have a blue tint on the surface of the ingot each side of the ridge or furrow, and good copper has a red, silky appearance.

Tin has a melting point of about 227 deg. C. It plays an important part in increasing the hardness of castings, and assists in forming a homogeneous alloy. In copper alloys it increases the tensile strength, but decreases the elongation according to the amount of tin introduced in the alloy. There are two ways of making a rough test of tin to ascertain its purity. If a piece of tin is melted and poured into a small ingot having the tin near its freezing point, and the surface remains bright, the tin is pure. If it takes on a dull or frosted appearance impurities are present. This appearance becomes very marked if lead is present in the metal. Another way to test the purity of tin is to take a small bar sawn from an ingot and bend it; if it produces a crackling ound it is a rough indication of its purity.

Spelter has a melting point of about 416 deg. C. It has the opposite effect to tin in alloys, as it reduces the tensile strength but increases the elongation. When placed under pressure or subjected to friction it heats very rapidly. In making bearings the spelter content is sometimes reduced, and a small amount of lead added to reduce the friction.

### Scrap.

Scrap is one of the most difficult things the brass-founder has to contend with; and while, no doubt, there is an economical advantage in the liberal use of scrap metal for the production of small, ordinary castings, to be successful some judgment is required in sorting and adding the required amount of spelter and tin to get a successful result.

The colour of an alloy is not always an index to its character or composition. It is possible to get a copper-spelter alloy containing a greater amount of spelter to appear darker than one containing a lesser amount. The colour of substances are due to the absorption of light rays on their surface. Metals, in common with some substances, not only absorb the rays rapidly, but throw off a metallic reflection. The rapid absorption of the rays causes the metal to appear opaque, which, combined with oxidation of the surface of most scrap metals, makes it next to impossible to attempt a guess at the composition by a surface examination, such as would be given to it in the usual way of working.

Aluminium-bronze has been purchased for brazing metal. Fire-box copper, containing manganese and other metals introduced by the makers of this special class of work, has been the source of many troubles when introduced into the foundry to take the place of virgin copper.

A safe way of producing a large number of castings uniform in colour from scrap is by the use of an air furnace. The metal can be melted and run direct from the furnace into ingot moulds and stacked for future use. Scrap and borings treated in this way can be subjected to an analysis, which will determine the deficiency of tin and spelter. The amount required can then be added when the ingots are used.

### The Air Furnace.

A furnace of convenient size is one holding about 30 cwt. of metal. The work of an air furnace is peculiar to itself, and should be carried out by a capable and intelligent workman. The main points to be kept in view are uniformity in fixing the furnace, raising the temperature quickly and keeping it as constant as possible, creating a reducing atmosphere when firing or charging and protecting the metal from oxidation and furnace gases. From 4 cwts. to 5 cwts. of metal will be sufficient to start a bath in the well of the furnace. The temperature should then be raised as quickly as possible. When the metal is melted more can be added, but only sufficient to be contained in the bath, as a large amount of metal in a plastic state exposed to oxidation and furnace gases means disaster.

When firing the furnace the damper should first be lowered; this will prevent air of a low temperature passing through the furnace during this operation. The coal should be spread evenly over the whole surface of the furnace and not be banked at any time, as this will cause variation of the temperature. When a large amount of fuel is put on it chills the fire and gives more hydrocarbons than there is air to burn. Smoke follows until oxygen and heat again give a proper state of combustion. The trouble is gas being produced at a temperature with insufficient heat to ignite it.

* Paper read before the London Branch of the British Foundrymen's Association, April 13, 1917.

To remove clinkers from the furnace the following is a good method :—Insert a flat rod between the fire bars and use as a lever to lift the clinkers up through the burning mass of coal; they can then be removed through the furnace door with the aid of a rake. This should be done immediately before firing. Lower the damper before charging the furnace and keep the surface of the molten metal covered with charcoal. Any pieces of hard wood and old bags filled with sawdust thrown in will assist in economising the consumption of charcoal and prove very effective. When the metal is ready to be tapped from the furnace a little phosphor-tin or phosphor-copper added will assist in reducing any oxide. The metal can then be tapped direct from the furnace to the ingots and broken into convenient lengths for use.

Low-priced coke is not always the cheapest; coke to be efficient should be low in sulphur, high in carbon and uniform in structure, with a metallic lustre when broken; inferior coke, when packed round a crucible, will be consumed in an irregular manner, leaving cavities where the air will pass up, reduce the melting efficiency of the furnace and add to the danger of oxidation of the metal. Greater efficiency can be secured by insulating the furnaces, building them in tanks on the Carr principle. The internal dimension of the furnace should be from 3 in. to 4 in. larger than the crucible. The furnaces should be separated from each other by a space of 8 in. They can then be given a coat of whitewash frequently, which will add to melting efficiency by resisting the transmission of heat to the outer atmosphere.

There are many oil-fired furnaces on the market, and a thorough investigation should be made before purchasing one. Many of these furnaces are indifferently designed, too much heat being absorbed by the furnace sides, the flame striking too direct on to the crucible, preventing a circulating flame and causing imperfect combustion in the furnace. Furnaces designed and experiments carried out with expensive oils will not prove very economical under ordinary working conditions.

### Faults in the Metal.

Faults in the metal which are usually developed in the foundry are the inclusion of oxide or dross and gas or blowholes. Although many of these defects are not visible to the eye, much can be done to eliminate them. When many castings have to be poured from one crucible frequent dipping of the skimmer deep into the metal can prove a source of trouble. As the skimmer is taken off the surface of the metal between each pouring it should have a fresh coat of blacking with each crucible and skimmed over the surface.

Excessive dampness in a mould causes steam to generate; the metal, owing to damp surfaces, becomes chilled, and the steam being trapped, forms small or large areas of resistance, floating or moving under the chilled surface to the most liquid parts, where they finally come to rest during the freezing or solidifying period. The same defect can be caused from insufficient venting with a tightly-rammed mould and defective cores. Gas holes, due to dissolved gas in the metal, usually separate out into numberless small cavities sometimes very deep-seated in the metal, where the gases are trapped during solidification.

The metal should be taken from the furnace immediately it is ready, and not be allowed to soak, as it will take up gas under this treatment. Inclusion of oxide or dross is a continual spectre in the brass foundry, and is not easy to remove once it is included in a metal. Remelting as a remedy (as in the case of gas-holes) is not sufficient in the case of oxidation, without the aid of deoxidisers. There are many of these on the market claiming to be more or less successful. In removing metallic oxides there is a danger that many of them produce in the metal a form of gas causing castings to be porous. Phosphor-copper and phosphor-tin are now used for the purpose of deoxidising non-ferrous metals with considerable success, and when used in small quantities do not alter the character of the metal to any extent, but allowance should be made for the amount of tin used in this way.

A very satisfactory method of cleaning metal is to place some plaster-of-Paris in the bottom of the crucible before placing any metal in it. After the crucible is taken from the furnace the alloy is stirred with an iron rod reaching down to the bottom of the crucible. The plaster-of-Paris will then rise through the liquid and carry with it any oxides that are entangled in the metal. Don't be afraid to use an iron rod for stirring the metal. The small amount of iron taken up by the alloy in this way will also act as a deoxidiser and improve the mechanical properties of the alloy.

It has been contended that iron in bronze, gun-metal and brass separates out into masses. Although this is so when considerable quantities are introduced, the amount taken up from the rod can scarcely be associated with the term alloying as understood by the foundryman. Iron-bronze was in use on the Continent as far back as 1850, and contained up to 5 per cent. of iron in a mixture of 90 per cent. Cu. and 10 per cent. Sn. Some have been found containing as much as 10 per cent. in metal used for making field guns.

The value of salt as a flux is well known, but is objected to on account of the fumes given off, which are very irritating to the workmen. Yet if these fumes are prevented from rising its most valuable aid is lost, as it readily combines with sulphur, and goes off in combustion, forming continual protection to the metal during the period of and after being reduced to a liquid. Glass as a flux is efficient, but should not be used in quantities more than enough to form a thin film over the surface of the metal. When glass is used to excess it coats the sides of the crucible, and when the crucible is placed in the furnace again the glass has a tendency to split off, taking with it flakes of the crucible, thus reducing the thickness of the crucible and lessening the number of heats.

Chloride of lead is useful when the scrap to be melted is very dirty. Plaster-of-Paris should be used in the manner described, and when the crucible is taken from the furnace the chloride of lead should be added by enclosing it in a piece of paper and, tying it to the end of a rod, plunging it as quickly as possible to the bottom of the crucible.

### Defective Castings.

In many cases defects in castings (oxidation and porosity) are not discovered until they are subjected to machine operation, when removal of the surface reveals them. Under the name of scientific management many firms credit the foundry account with cost of work done to a faulty casting. This method has led dishonest people in the turnery to take deep and unnecessary cuts over work which they know will be finally rejected, the cost being set to the foundry's charge. Many castings are scrapped in the fitting-shop which

need not be with a little co-operation between the turnery and the foundry.

To " burn in " a defective part of a casting subjected to an ordinary mechanical use is a simple process, but with a casting of a valve-box or corresponding type to stand a considerable amount of pressure it is another matter, especially if the walls of the casting are thin. A thin-walled casting in bronze or gunmetal has a marked degree of chill effect, even when cast in a dry-sand mould, especially if it has been allowed to cool before the metal is poured into it. A casting of this type to be " burned " successfully should have the whole of the affected part cut away; previous to cutting away, impressions in the form of loam cakes should be made of the part to be replaced. This method

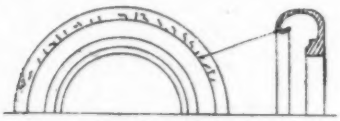

Fig. 1.

will allow the casting to be made very hot, when the loam cakes can be placed in position, rammed round with sand, and secured by a backing of weights, stays or boxes, the metal being poured into the part for burning while the casting is hot. If metal is burned on to a thin-walled casting which has not been made hot immediately before burning-in, a fracture or a series of small fractures will develop, running part of the way round the edge of the area formed by the new metal. This is caused by unequal contraction.

As soon as a casting of the foregoing type has been burned it is a good plan to throw a little sand into the furnace and place the casting on

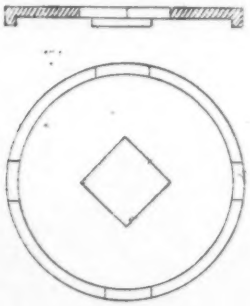

Fig. 2.

top. If burns can be done at the end of the day this can be accomplished without the inconvenience of holding up the furnace during working hours.

Bronze, gun-metal and brass castings can be hardened by work or pressure, and sometimes the foundry gets called to account for this. Two cases with which the writer was concerned may prove interesting. The first, Fig. 1, was with gun-metal rings. The casting was turned over the whole of its surface. It was discovered that fractures were developed round the edge of the curvature part of the casting. The foundry was informed that the metal was at fault; castings that were broken revealed fractures with a white appearance on the surface. After investigation it was found that the tool passing over the surface near the edge (the thickness of the metal being 1-16 in. on the curve) hardened the casting at this point. when the tool passed to the inside it set up a number of fractures which developed in length with the operation of the tool.

The second instance, Fig. 2, was faults developing in discs used in connection with electric brakes. The casting was a 10-in. disc $\frac{3}{8}$ in. thick, of phosphor-bronze (80 Cu., 10 Sn., 9 Pb., and 1 of 15 per cent. phosphor-tin). Although this alloy should stand heavy pressure, shock and vibration, the metal hardened under the influence of the brake working in an irregular way, and some of the castings fractured into as many as five pieces.

### Test-Bars.

Test-bars are not always satisfactory under mechanical test when cast attached to the casting, although the alloy may conform to specification as to its chemical analysis. The sketch, Fig. 3, illustrates how a satisfactory conclusion was arrived

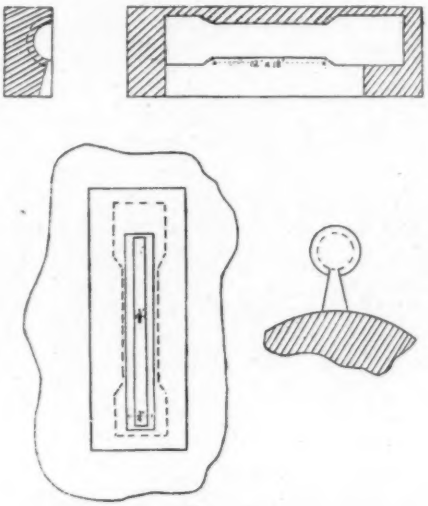

Fig. 3.

at after experiments had been carried out on several castings from the same patterns and composition of alloy. The main points were (1) to get a bar on the castings that did not trap impurities in the vital part; (2) to decide whether the test-bar should be at a sufficient distance from the casting to cause rapid freezing; (3) to determine the position the test-bar should occupy in the mould. As to the first point, it was thought the practice of having an entry at one end of the bar was not the best. The bar would be partly filled with a sluggish metal, and probably cause porosity. The bar should have a head at the top sufficiently large to allow impurities to pass into if possible. Next, the test-bar should be placed as near to the face as possible to get the flow of hot metal, the runner part being designed to act as a temperature check to allow the bar to reach freezing point as soon as possible. The bars should be placed near the bottom, occupying a position where there is pressure in the mould. It was thought not to be advisable to spread test-bars over the whole surface of the mould, as it would assist in lowering the average of the tests.

### Sand and Vents.

The sand found in the Southern counties is generally suitable for brass-foundry work, and fairly heavy work can be cast in green sand of this type. Gun-metal bearings of 300 lbs. and phosphor-bronze up to 70 lbs. have been so cast, the sand being milled and sifted for the face, and the mould finished by sleeking plumbago on with a trowel. The sand should be rammed fairly hard and be well vented. The writer considers it advisable to vent any brass mould, especially one containing thin flat castings. In support of this statement, thin gun-metal name-plates, 10 in. by 14 in., were running with faint edges; venting the top was resorted to, leaving the top of the mould without being sleeked, with the result that every casting was perfect. If gas wants releasing from a mould and venting assists, it is logical to employ that method.

### Discussion.

The CHAIRMAN, referring to the question of venting, said that although this was a controversial matter, he personally believed that venting was an advantage in every instance, no matter what the metal was.

MR. J. STONE asked the author, with regard to the test-bar, what method he would adopt with smaller castings and running the test-bar to get the specified tensile and elongation.

MR. BARRETT said the method he had illustrated was adopted for all kinds of castings. Answering Mr. Aston, as to the proportion of plaster used, it was the custom to throw a handful into the bottom of a 160-lbs. crucible before placing the metal in. The metal must be placed in and not dropped in, otherwise the plaster-of-Paris would be displaced and thrown up the sides of the crucible.

MR. A. HAYES asked if trouble had been experienced with excessive sulphur content, when using plaster-of-Paris.

MR. BARRETT said there was excessive sulphur, but it was very apparent, and trouble only ensued if the pot was not skimmed clean. He did not advise continual layers of plaster. It should be put at the bottom of the pot, and left there until the metal was melted, stirring the whole contents of the pot, and drawing it from the bottom.

MR. T. W. AITKEN said that with swarf it was a common practice to spread it all over, to sprinkle the plaster-of-Paris and mix them all together. That was evidently what Mr. Hayes had in mind when speaking of continual layers of plaster mixed with dirty stuff. The best flux for this was borax. Not very much was required, and a better value was obtained for the dross. He had found it most successful in the melting of brass swarf, simply a handful of borax and no other flux. In a large crucible, say, 400 lbs., half a dozen handfuls was necessary, but that was not very much.

MR. BARRETT said he had not touched this question in the Paper because he thought it was so well known. Borax was undoubtedly one of the best fluxes, and he adopted the plan of storing it near the furnace, so that it was always perfectly dry. This prevented the setting up of gases in the metal.

MR. AITKEN mentioned another point in connection with the use of borax, viz., that with a new pot, if when red hot some borax was sprinkled on the inside, a glossy coating was obtained which gave several more melts from the pot. The coating remained almost to the life of the crucible.

MR. HAYES asked if the author had ever attempted, in connection with iron, tin and copper alloys, to alloy a higher-carbon steel than, say, 0.3 mild steel. With high carbon trouble was experienced in adding iron. Certainly cast iron could not be added on account of the carbon content.

MR. BARRETT replied that he had never attempted to deal with that question, because it did not seem to have any commercial prospects.

MR. J. STONE said that with manganese bronze a certain percentage of iron must be mixed.

MR. HAYES said that with the complex manganese bronze the carbon had not such a big influence. He agreed there was not much commercial application for copper-iron alloys.

MR. AITKEN remarked that there were firms who supplied masganese bronze with iron up to 4 per cent. The Government issued certain alloys which gave certain tests in some of their classification work, and in one the iron was as high as 2 per cent., and the method of applying the iron in the form of wrought bars was described. Wrought iron was one of the purest forms of iron, and very low in carbon.

The CHAIRMAN, speaking of the test-bars, said the one shown in the author's diagram seemed to be very heavy indeed, if it were to be on castings of very thin section, say, 3-16 in. to $\frac{3}{8}$ in. Would the author suggest that the runner should be $\frac{1}{4}$ in. thick on such a casting, and proportionately thinner on the test-bar, or what thickness would he make the runner on very thin castings of that description?

MR. BARRETT said the test-bars he had referred to were cast on cylinder casings for auxiliary work on small sloops, and they were down to $\frac{3}{8}$ in. thick. The test-bars were one on each side, and he believed the runner part nearest the casting was the same thickness as that at the test-bars, viz., $\frac{1}{4}$ in. thick, because it was found that if the test-bar side was much bigger, there was a tendency to distort the surface.

The CHAIRMAN said that if the test-bar runner was heavier in proportion to the casting, there must be a great deal of distortion in the casting, if the casting was of thin section. The test-bar would be the last thing to cool, and there would be some distortion and contraction cracks showing in the casting. Therefore, it would be much better if the test-bar could be run with a different top runner and not a runner the whole length of the casting.

MR. BARRETT said the test-bar was not carried the whole length of the casting in the case he had mentioned on account of the irregularity of the surface. He always put the runner on the straight part of the casting. The test-bar was run directly off the runner, but he did not recommend such a test-bar if it were possible to get it off a piece of the casting.

MR. J. GAUNT referred to the remarks in the Paper with regard to the area of the furnace compared with the area of the pot. He was present at the recent Institute of Metals meeting when there was a great discussion on metal melting, and most of the speakers seemed to prefer the square furnace. One of them, he thought, made a rather unfair comparison between the square and the round furnace. He took the available coke area of a square furnace allowing $1\frac{1}{2}$ in. on each side, and calculating the area of a round furnace and allowing 3 in. all round, he argued that the square furnace would be more economical. Personally, he should not allow more than 2 in. for a round furnace.

MR. BARRETT said he had mentioned the furnace

being 3 or 4 in. larger than the diameter of the crucible. He liked the square furnace himself because there was a better chance of using all the coke. The corners could be packed with heavier coke, and smaller coke could be used on the sides of the furnace. By so doing, there was less tendency for a tunnel to form, and the large coke in the angles held up to the end of the melt. In this way he fancied that square furnaces were more economically fired than the round furnace.

Mr. Aitken suggested that this only referred to natural-draft furnaces. What was the author's experience or his opinion as to forced-draft furnaces? One particular forced-draft furnace on the market made the claim of saving in fuel by the small area of coke, about 2 in. round the crucible, but his experience of this was that it is false economy. In the first place it was necessary to break the coke up very small whilst the forced draft during the melt was blowing almost directly on to the crucible where there was no coke. So dissatisfied was he that he built a furnace himself, and had tried it for the first time that day. He put 4 in. at the top and 6 in. at the bottom. He was not melting non-ferrous metals, but where he was melting steel this furnace did in 2¼ hours from a cold pot what previously took 3¼ hours, and when he got the figures of coke consumption, he thought it would be found to be much less by being able to pack a larger area. The same thing might apply to a natural-draft furnace. When the fuel was not packed sufficiently round the furnace, cavities were formed which resulted in loss of heat.

Mr. Barrett said that he once used a forced-draft furnace, and was agreeably surprised at the result both in speed and consumption of coke. He came to the conclusion that if it was ever his lot to have the furnace he wanted, forced draft would be the one he should go in for.

Mr. Gaunt said another point was that in the discussion at the Institute of Metals several speakers claimed that they got 80 to 100 heats per pot. They did not explain what type of furnace they were using, but it was rather beyond him to get so many heats. What was the author's opinion of the number of heats that might reasonably be expected from a crucible?

Mr. Barrett said the number depended largely upon the furnaceman. His experience with a coke-fired furnace, lifting out with tongs, was that 28 heats was a good result. Usually 20 or 21 was considered an average number. But in general foundry work there were many things that could not be done that were done in experimental work. The structure of crucibles was not very uniform. Very often where a crucible had broken or worn through there was an area of markings where the crucible had been made. He believed that was one of the causes of premature breaking of crucibles.

The Chairman mentioned that Messrs. Weir's, of Glasgow, had four foundries, and the foundry foremen considered that if they got 30 heats out of each pot they were getting satisfactory results. To encourage the furnacemen, however, they gave one penny for every heat over 30, and it was found that another 30 were obtained.

Mr. Aitken said he started his furnaces at 9 o'clock on Sunday night and finished at 12 o'clock on Saturday, and got 22 melts per day of 24 hours. Two pots were run through the week, and this gave an average of 55 melts from each pot. With regard to the manufacture of crucibles, it was an extremely difficult thing to make a crucible. No matter how much one complained, the result was the same, and he did not think they could help it. The furnace he had mentioned was a coke-fired tilting furnace, but with pit fires he had never got more than 18 melts per pot. He had the gas-heated lift-out type, and did not get any more from them, but with a portable tilting furnace there was a much greater life of the crucibles. Another 10 or 20 melts could be obtained if they were properly looked after. He also had a 700-lbs. oil furnace, and with this he had to use three pots instead of two with the coke, running the same number of melts. The flame affected one side of the pot, and he preferred coke to oil. The oil furnace was a fixed bottom, whereas the majority of coke furnaces were open bottoms. With the open bottom it was possible, if the pot failed or the furnace failed, for the furnace to cool quickly, and a new crucible could be put in in a very short time. With an oil furnace, he could never get a new crucible in under five hours. The heat was retained in the bricks for so long that it was impossible to go near the furnace, even with a blast to cool it down. That was a consideration in choosing furnaces.

Mr. Stone asked the author's opinion of the old system of cast-iron cylinders in furnaces; *i.e.*, taking them out and relining whilst running. With regard to forced draft, he had a furnace under his supervision for some time fitted with pre-heaters. There were three furnaces; in one he melted steel, in the second gunmetal, and in the third he pre-heated the metal for the others.

Mr. Barrett said that was possible owing to the intense temperatures used, but in very few brass foundries did they ever touch steel. As to oil furnaces, one of the difficulties he had encountered was that of obtaining sufficiently perfect combustion to make the furnace go well. Oil furnaces and electric furnaces were very much in their infancy, and there was a lot to be done to get them to perfection.

Mr. Stone pointed out that one of the difficulties with the oil furnace was that the shop was cold when starting up, and the oil was thick in the pipes and did not run freely. Some kind of heating apparatus was required in the shops where oil was used, otherwise it was impossible to get perfect combustion.

Mr. Aitken said he also had experienced this. He had three barrels of oil frozen like jelly. The oil supply was by gravitation, and there was no means of forcing it. His own burner was a low-pressure burner, but there were a good many high-pressure burners on the market in which the atomisation was much better and there was very little smoke, but he had not had many complaints of nuisance from neighbours as to smoke, except at the start, when the combustion was not perfect. He used creosote oil from the gasworks, because he could not afford at the present time to use any other, and there was trouble in the cold weather through the oil being too thick to flow down in sufficient quantities or to atomise. That difficulty, however, he believed was likely to be overcome, because he had supplied some oil to a firm to experiment with, and they got much better results than he had been able to. The oil was used in an engineers' shop with the men at work, and there was no semblance of smoke in the place. The combustion was perfect, but the air pressure was 4 lbs. against his 12 ozs.

Mr. Stone said he used anything from 25 to 30 lbs.

# Pattern for a Large Main Circulating Inlet Valve.

By James Edgar.

The first thing to be decided when making a circulating inlet valve of the type shown in Fig. 1 is whether the square chest shall be made in the form of a shell pattern, leaving the moulder to cut a print in the sand and use the inside as a corebox, or whether a block pattern shall be used with a corebox. Both methods of construction have advantages. The shell pattern is certainly more economical, as it takes much less timber, and the expense of making a corebox is saved. It is also much lighter, and this is a very distinct advantage if the pattern has to be tried to place in the ship. On the other hand, a blocked-up pattern will stand much longer, and prove cheaper in the end, if many castings are wanted. However, it is very seldom that more than two or four castings of such a chest are wanted. It is usually necessary to "hand" this job, as there are almost certain to be cross angles on the flange of the square chest. This flange fits against the shell of the ship, and the position is usually marked in the drawing, the numbered frames being given. Occasionally approximate distances are given on the drawing, and after the pattern is made it is checked at the ship, but more often moulds or templets are supplied by the mould left from which the pattern is made, and sent off to the foundry. If the pattern-maker has to try it to place, a distance will be given from the line A B to a datum line, and, of course, the top flange must be level.

Two half-lapped frames should be first got out to make the joint of the pattern. They are dowelled together, and should be made of 1¼ in. or 1½ in. stuff. It will be noticed in Fig. 6 that the frames include the branch C. It makes a much stronger job to make the frames to the face of the flange than to fit the branches quite separately.

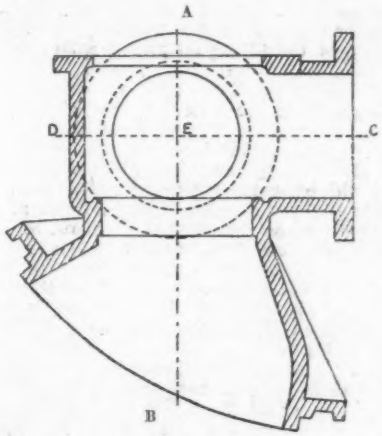


Fig. 1.

Fig. 2.

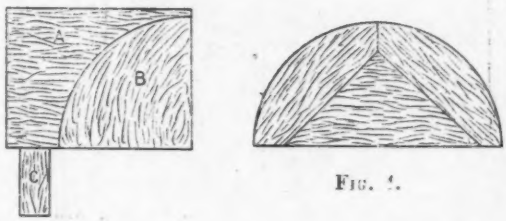


Fig. 3.

Fig. 4.

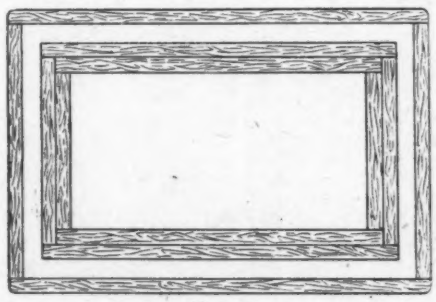

Fig. 5.

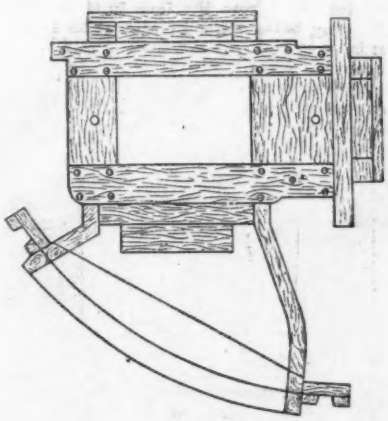

Fig. 6.

It is well to make the main body D with grounds and staves, carrying it out to the face of the cover flange. The cover flange, not being thick, can be screwed on top. A really strong job can be made of the staved-up body by fitting three stays about 3 in. broad by 1½ in. thick, and letting them into the grounds as shown in Fig. 2.

When the body has been fixed in position, the

branch can be got out. It should be blocked-up solid, and if a templet is stitched to it and a block screwed on the face to keep it square on the table, it can be cut at the bandsaw. The arrangement is illustrated in plan in Fig. 3, A being the templet, B the branch, and C the squaring block. The flange can be screwed on the face. The prints for the branch C, Fig. 1, which would be 16 ins. diameter if it was a 16-in. valve, and for the end of the chest, which will be still larger, had better be made with a 1-in. plate thicknessed with 2-in. timber on the back, as seen in Fig. 4. The top

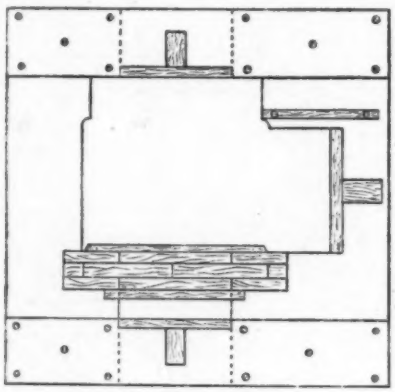

Fig. 7.

branch E, Fig. 1, unless it is very shallow, will be better built with segments. If it is very deep it can be staved, but staves have the disadvantage that they cannot be fitted and screwed as well as segments. The flange for this top branch must, of course, be dowelled on.

The square chest ought to be made and finished quite separately from the valve body and screwed on afterwards. It should be made to a line sufficiently far back from the face to clear the angles, the handing being done by alteration strips. Two plates have to be made for the top and bottom, and they can be temporarily battened together. Two ends can likewise be got out. The side pieces must be very carefully drawn off and dowelled together on edge. To build this chest one of the end squares

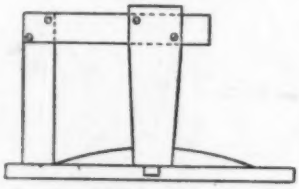

Fig. 8.

should be first screwed to the bottom plate, and two sides screwed on. The top end piece can now be laid on top of the other, and two temporary battens screwed on the outside. The dowelled sides can now be put in position, and temporary battens likewise screwed on to them. The top plate can now be put on. The method of building one half on top of the other has obvious advantages. If care has been exercised in squaring and dowelling the sides, the top should lift "sweetly" from the bottom and without any drag. When the corners of the chest have been rounded off, the battens can be removed, and each half screwed to the valve body. A print will have to be screwed inside this chest to carry the body core. It will be observed that the print is smaller than the core for the valve seat, to allow sand around it.

The flange and the fitting strips on the face can now be attended to. Pieces ought to be screwed on, carrying the body to the face of the flange. It is usually possible to change the chest from port to starboard, by changing the top piece to the bottom and the bottom piece to the top. The side pieces can also be turned upside down. The flange will have to be screwed on, taking care that the flange on the moulder's bottom half is screwed from the inside of the chest and on the top half from the outside. It is not necessary to explain the making of the fitting strips and spigot, which are screwed on the face. The moulder, of course, will have to loosen off these strips and also the supporting ribs on the sides. A view of the face is shown in Fig. 5. The joint of the finished pattern is shown in Fig. 6.

In a valve as large as this a plate or an open frame would be quite satisfactory for the body core. Some foundries prefer a plate, others prefer a frame. From the pattern-maker's point of view the work is the same, except that if a plate is made the end grounds for strickling the core will be a half diameter, whereas if a frame is used they will be a half diameter less the thickness of the frame. A plan of the frame with the grounds on is shown in Fig. 7.

A bridge piece should be made to carry the valve seat. It can be built in two or three thicknesses, and should be about 3 in. broad. A runner is screwed on each face of this ring, and the strickles will work on this runner and the end ground. If an end ground is made for the branch it can be strickled with a semi-circular strickle, guided by a strip on the frame.

There is still a top branch core to be made. It is 16 ins. in diameter, and might be made with a pin board, as shown in Fig. 8. It may be that the moulder will prefer a box, and one can be made almost as cheaply as the pin board. An end view of a suitable box is shown in Fig. 9 and a plan in Fig. 10. It is simply a square frame with

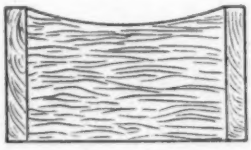

Fig. 9.

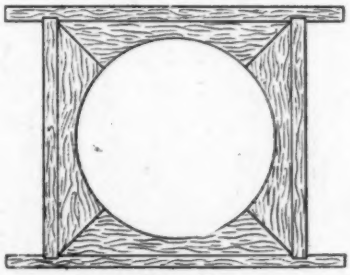

Fig. 10.

mitred skeleton pieces nailed inside. A skeleton box made in halves would be almost as expensive as a solid box, and this style is as convenient for the moulder, as it can be taken apart like any ordinary frame corebox.

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The National Steam Car Company, Limited.—Anticipating difficulty in obtaining steel, the company have erected an electric steel furnace and foundry at Chelmsford. By this means they are able to produce wheels and castings for their 'buses and transport vehicles from their scrap material.

# Modernising a Basic-Bessemer Plant.

In order to cope with a rapidly increasing demand for steel the Aumetz-Friede Company, in Kneuttingen, Lorraine, was obliged, about four years ago, to reconstruct and modernise their basic-Bessemer plant. The work had to be done without interfering with the operation of the existing plant, which was installed as recently as 1900 with four converters, to which a fifth (No. 1) was added in 1909. The next year a circular mixer of 800 tons was added to the already existing two pear-shaped mixers, of 175 tons each. The lime and scale were orginally conveyed to the bins in small tipping trucks, running on a narrow-gauge track, and were raised by a lift to the high-level platform. Later this arrangement was imimproved by the adoption of cable haulage.

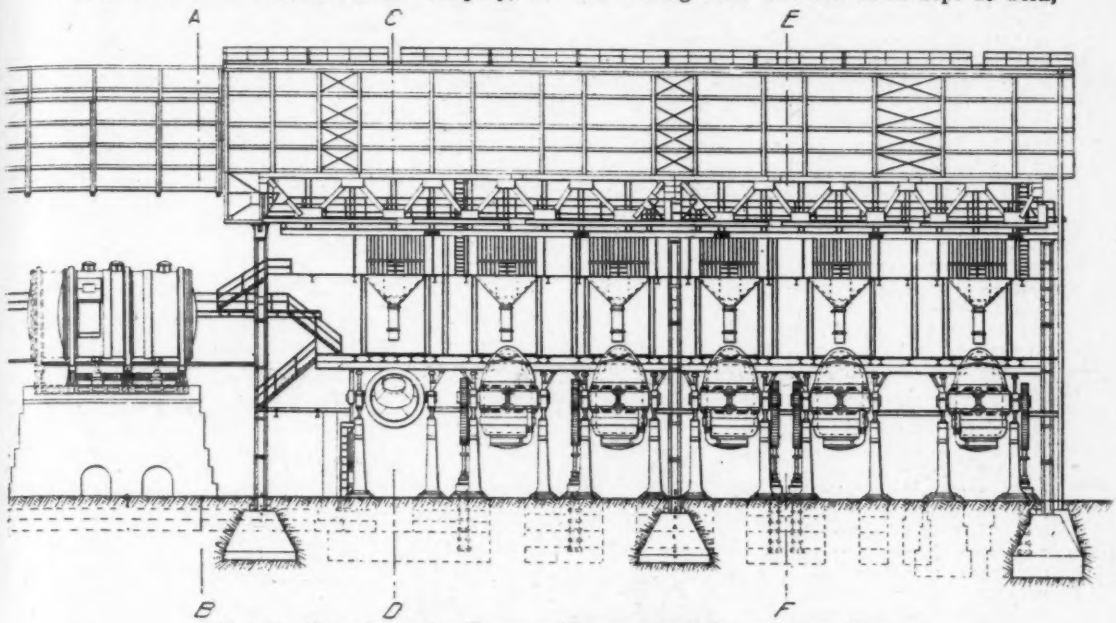



FIG. 1.—BASIC-BESSEMER PLANT AT KNEUTTINGEN; LONGITUDINAL SECTION.

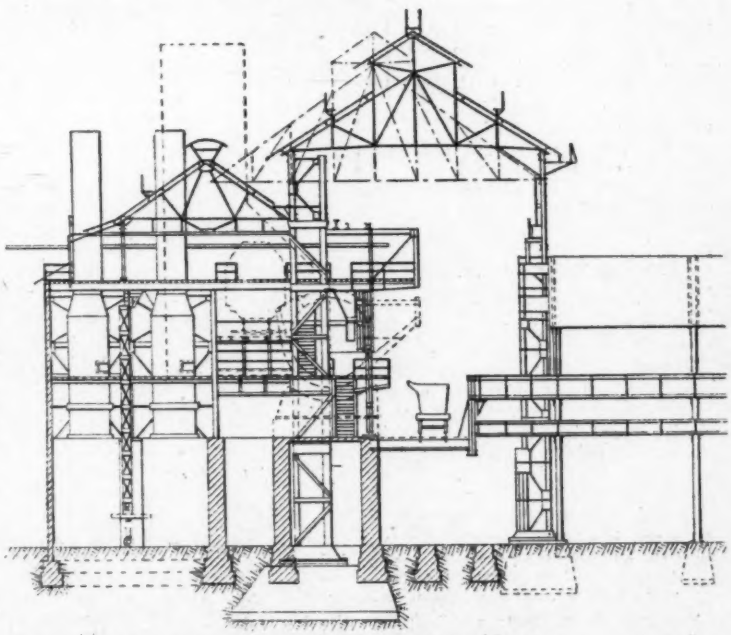


FIG. 2.—CROSS-SECTION ON A B (FIG. 1).

Eventually the addition of a sixth conveyor became urgent, which could not start work, however, until the new building and the new cable line for the haulage of the trucks carrying lime and scale was finished right up to it. On the other hand, the existing cable line had to be kept at work, which necessitated raising the new lime platform and the new cable line so as not to interfere with

the working of the old plant. When the work of reconstruction had reached this stage the four original converters (Nos. 5 to 2) could be re-built one after another, and the new cable line could be used for serving them, with certain makeshifts until the old cable line could be put out of commission and removed. No. 1 converter, the one added in 1909, was left undisturbed, as it was already working with heavier charges than the other four. The annexed cut (Fig. 1) is a longitudinal section of the modernised plant, showing the latest (No. 6) on the extreme right. Figs, 2 3 and 4 show cross-sections at the points indicated in the longitudinal section.

The new converters had to be placed in such positions that they could be charged from ladles on trucks running on the low-level platform, which necessitated setting back the centre line of the four replace converters by about 12 in. behind their old centre line, the break in the centre line necessitating the adoption of ladle-trucks, with a traversing motion for the ladle. The spacing of the four original converters was about 27 ft. apart, which could not be altered if the old foundations were to be utilised, and to allow the adoption of converters of somewhat greater capacity without unduly spreading their bases arrangements had to be made for conveying the air to the blast boxes by two pipes, one on each side. Much stronger bases had to be provided to carry the new heavier converters, and the floor of the charging platform had also to be strengthened to carry two ladle-trucks following close upon each other. The level of the existing charging platform could not be altered, and had therefore to remain at about 21 ft. 4 in. above ground level, but the level of the new high-level platform had to be raised above the level of the old cable line for reasons already stated. The level of the new platform was fixed at about 53 ft. above ground level. The reconstruction of the chimneys received special attention, with a view to preventing injury to the steel framework during tapping and the ejection of incandescent material. There is a gangway with peep holes for the inspection and cleaning of the shafts.

To provide for a future probable increase in the output, a crane-road has been provided so that overhead travellers may be able hereafter to assist the ladle trucks in carrying molten metal from the mixers to the converters. Owing to the impossibility of placing stanchions at suitable intervals, the girders carrying the crane road had to be arranged in large spans.

To provide more room for the new chimney shafts one of the existing walls had to be pulled down, and a new wall had to be erected at some distance from the old wall. The new roof was fixed at such a height that the old roof could remain in place until the new one was finished.

The air blast for the converters is supplied by reciprocating blowers driven by a double-acting four-cycle gas engine with two pairs of cylinders, each pair in tandem with a blower.

A new 1,400-ton mixer has been added to the plant, and more blast furnaces have been erected, so that the output of the whole plant was increased from 720 tons to from 900 to 1,000 tons of blown steel per shift, which can be further increased if required without any difficulty. The whole reconstruction did not occupy more than a year, notwithstanding the difficulty of erecting girders about 88 to 98 ft. long, and the heavier ones weighing 78 tons, for the crane road over a busy shop.

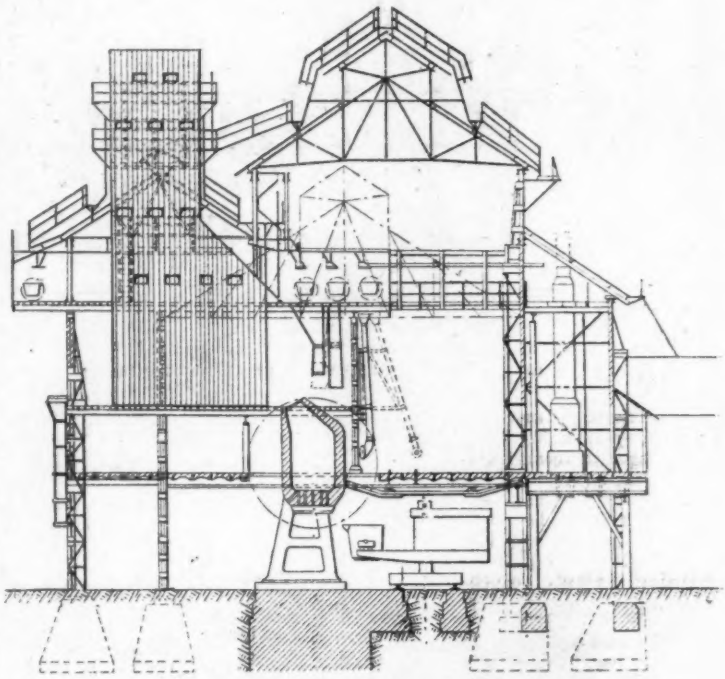


FIG. 3.—CROSS-SECTION ON C D (FIG. 1.).

**LARGEST INGOT MOULD CAST.**—The Bethlehem Steel Company recently cast the largest octagonal corrugated ingot mould ever cast in the United States. Its dimensions are 15 ft. 7 in. in height, with a mean diameter of 91½ in. At the thinnest section, or point of corrugation, the metal is 15 in., while the heaviest section is 20¾ in. thick. Three hundred and forty thousand pounds of metal was charged into the furnaces, and after the mould had been filled, 10,000 lbs. more iron was brought from the foundry, three-quarters of a mile away, to pour into the sinkhead to feed up the shrinkage of metal. This added metal was filled in about a ton at a time for 3 hours, when the shrinkage stopped; the metal, however, remained liquid 5 hours after pouring.

# Vertical Moulding of Hydraulic Pipes with Belts.

By C. Thomas.

Fig. 1 shows a ring containing six bars, and its use is to contain the runners and centre the core at the top. It is machined on the bottom flange, which is also drilled to take three dowel pins, which are of unequal pitch. It therefore will fit only in one place, and when jointing the flask up again after drawing the pattern, etc., it is bound to go on again in the same position as it came off. The centring of the core depends on this, and the unequal pitch of the dowels prevents any possibility of placing it on out of centre.

Fig. 2 is made in halves, machined on the joint, top and bottom. The joint flanges are drilled for two dowel pins, and in the top flange are placed the three dowel pins of unequal pitch. Round the inside at the bottom is cast a lip to carry the sand; also two square holes are cast in each half as shown in the sketch. The holes are provided so that a square bar of iron can be placed through the flask before ramming up. This will prevent the sand dropping out. The bars are shown in the half plan and are marked X.

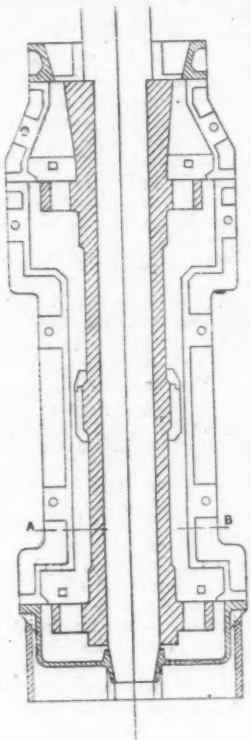
Fig. 3 shows the main or body flask. This also is provided with holes at the bottom end for the bars to carry the sand. Round the inside at the bottom is also cast a lip to carry the sand. It will be noticed that holes are provided for ramming the bottom end of the flask. They are marked *a* on the drawing. The flask is machined on the joint,

Fig. 1.

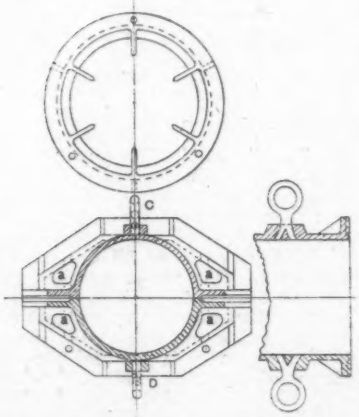
Fig. 2.

Fig. 3.

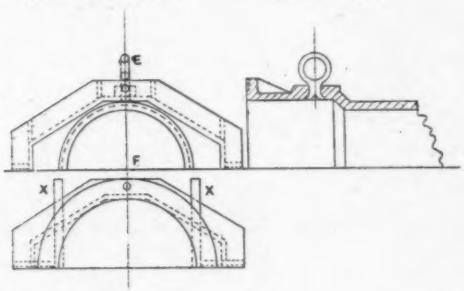
Fig. 4.




Plan of Fig. 1.

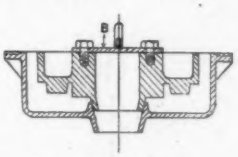



Section of Fig. 1 on A B. Section C D.

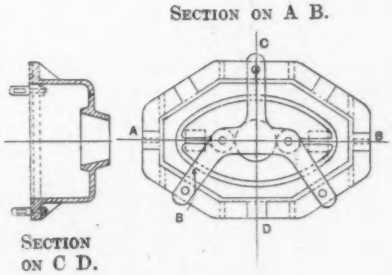



Plan of Fig. 3. Section E F.

Plan of Fig. 2.




Section on A B.




Section on C D.

Fig. 4.

top and bottom, and all the joints are provided with dowel pins as shown. Lifting bows are cast in each half, one near the top and the other near the bottom. This flask should allow not less than 2 in. of sand round the pattern.

Fig. 4 shows the part that contains the bottom flange, and centres the body core. It is machined

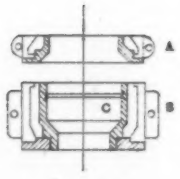



FIG. 5.

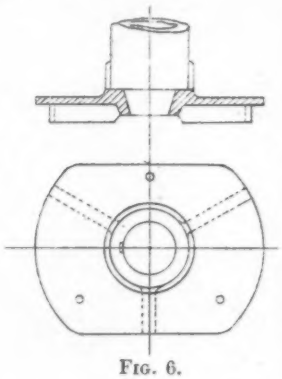


FIG. 6.

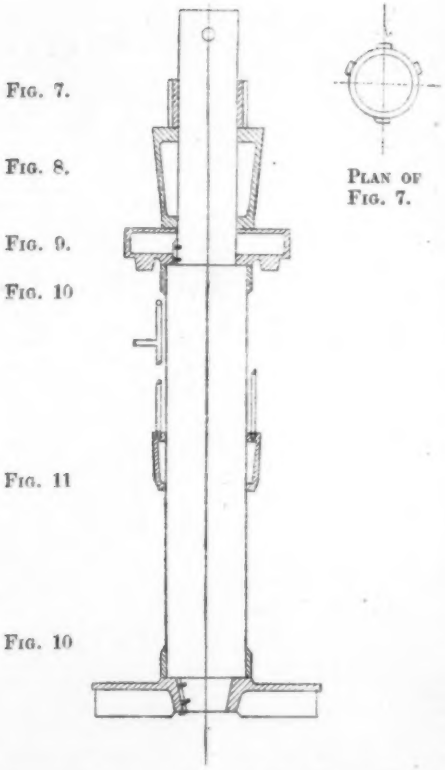


FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10

FIG. 11

FIG. 10



PLAN OF FIG. 7.

on the top flange, and the seat for the body core is bored out. Care must be taken when drilling the holes for the dowel pins in the top flange of this part, as on them depend partly whether the top flange of the pipe is out of winding with the bottom one.

The method adopted is as follows. The straddle marked B to which the bottom flange pattern is fastened is made of steel plate and machined on one side. The five holes are set out and drilled. The bottom flange pattern is faced on the back and the seat turned. A line is also scribed on the back of the flange, passing through the centre of the prints. The flange is now placed in the seat of the flask and a continuation of the line nicked in the flange of the flask. The straddle is placed on the top and the holes marked off, two in the flange and three in the flange of the flask. A template is now made the shape of the flange of the flask, having the holes drilled in and a wood plug to fit the seat of the flask screwed to it. The wood plug should be turned parallel from where it leaves the seat. All the other flasks can now be marked off with this template. The flask with the line nicked in should have the dowels fitted, and should be kept in the machine shop as a standard with which it will be possible to centre any other flange on the straddle. The flange pattern may be filled with wood to protect it where it is cored out to lighten it.

Fig. 6 now requires attention. It is essential that the dowel pins in this plate, which is machined on the face and bored out to receive the seat of the pattern, shall be exactly the same as the holes in the bottom of the body flask, which have been drilled to another template made as follows. This template should have a hole turned it to fit over the wood plug on the template used for marking the bottom flask. It is placed over the plug, and the holes marked off and drilled. The centre line is also copied off and a key-way cut in the template. To mark the bottom plate, the template is placed on the plate with the hole centred round the hole in the plate for the seat of the pattern, and holes and key-way marked off. This template should also be kept as a standard.

Fig. 5 shows two core-boxes for forming the belt in the centre of the pipe. The plate that A box is rammed on is a whole ring and the core box is in halves. The plate that B box is rammed on is a whole ring, as is also the plug C, which has a bar cast across the centre to form a handle. The core box is in halves. When making these cores a ring or two of wire or light iron should be rammed up in them. The inside of the cores should be blacked and core A then gummed on to the top of B. The outside is given a coat of gas tar to harden it, and the whole well dried.

Fig. 7 shows a wrought-iron ring with three runners and a riser fastened on. It is turned and bored a sliding fit on the pattern. Fig. 8 shows the riser head, machined and bored to slide on pattern; and Fig. 9 is the top flange pattern, which has a key-way cut in the bottom edge in a line with the centre of the core prints. It is machined on the top and bottom, and made a sliding fit on the pattern. It is cored out to lighten it, as shown, and it is advisable to fill the space thus formed with wood. This will strengthen it considerably. The body pattern is reduced at the top to a suitable diameter to give strength to the top flange, runner ring and riser head. The hole at the top of the pattern is provided for lifting. The chain is passed down the inside of the pattern, and a bar put through the hole and chain.

Fig. 10 shows wrought-iron rings machined all over; the bottom ring should be an easy fit on the pattern. Fig. 11 is a round print piece machined all over and bored an easy fit on the pattern. The diameter of this piece is made $\frac{1}{4}$ in. larger than the outside diameter of the core A and B for

forming the belt on the centre of the pipe. It is made 1 in. deeper than the cores are when they are placed together. It should also have a liberal amount of draft allowed on it. Fig. 12 is a stand for placing the flask on for casting. It has holes cast in the sides for lifting, and can be made open sand.

The flasks described above are the ordinary flasks used for making hydraulic pipes, and the following method describes how these may be adopted for making the pipes with belts on. The method of moulding is as follows :—

The bottom ring is placed on the pattern and

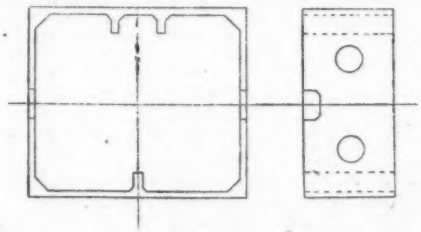


Fig. 12.

the pattern in the plate which is bored to receive it. The body flask is placed in position on the dowel pins, the square bars being put through the flask at the bottom to carry the sand before ramming. The bottom part is rammed through the holes provided, and the body rammed up a certain distance. This distance is to the bottom of the round print which is to form the centre belt, and is determined by placing a ferule round the rammer handle so that when the ferule is level with the top of the flask the sand is the proper height in the flask. The print (Fig. 11) is now placed on the pattern and lowered down the flask;

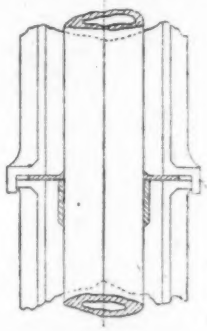


Fig. 13.

this print is provided with long handles, which have projections on them to rest on the top of the flask. They should stand ½ in. above the top, and then a face is got at the bottom by means of using this as a rammer till the projections are level.

A thin rammer is now used to ram between the print and flask. This having been rammed the print is drawn up again, and the core A-B placed on the pattern and pushed down to the face left by the print. The print being made ¼ in. larger in diameter than the core, this should enter easily. Ramming now proceeds in the ordinary way. The taper on the outside of A-B core at the top and bottom allows the sand to hold this in position.

The body core is made on an ordinary pipe-shop core bar, and is increased at the top to suit the outside diameter of the runner ring, and by this means it is centred at the top of the mould.

If it is desired to make special flasks for these pipes, jointed at the centre belt, the joint should be made by turning the outside of the bottom flask flange and boring the lugs on the other to suit. Dowels should also be fitted of unequal pitch to ensure the flask being jointed properly after parting. When ramming up the loose centre belt should be level with the top of the bottom flask, and then a plate machined on both sides slipped down the pattern before the top flask is placed in position. The use of the plate will become apparent when drawing the pattern. If it was not there the belt would come up with the pattern. Of course, allowance must be made in the length of the pattern for the plate, as this is removed when placing the flasks together again.

**THE VICKERS SURFACE-HARDENING PROCESS.**—The Vickers process of local surface hardening consists of applying momentarily to the surface of the part to be treated an intensely hot flame from any oxy-acetylene blowpipe. The effect of this is to raise the surface of the object to a high temperature, it being then immediately quenched by the cold body of the metal beneath. The equipment is that usually provided for oxy-acetylene welding, but the temperature of the flame is higher, the increase being obtained by adjusting the flame as for welding and then increasing slightly the supply of oxygen. The body of the work must be kept as cool as possible, to insure that the quenching is sufficiently rapid. For small parts it is customary to immerse them in cold water. Bodies of large parts may be left to cool off by themselves, but where necessary a supply of cold water may be allowed to flow over the work. In both cases the actual surface to be hardened is not to be submerged in water unless it is desired to give only a very shallow depth of hardened crust. The process is being largely used for gear-tooth hardening. In calculating the cost of the process for the purpose of comparison with furnace-treated work, it must be remembered that—whereas for the latter process it is customary for the machining of the work to be carried out to approximate dimensions only, so that any distortion due to the heat treatment may be corrected by grinding and straightening—in the local surface-hardening process the work is machined to the finished dimensions, since no distortion is caused by the process.

**ELECTRIC STEEL FURNACES WORKED FROM TOWN SUPPLIES.**—A writer in a recent issue of "L'Echo des Mines et de la Métallurgie" suggests the installation of electric furnaces in towns, in order to utilise the electric units lying idle at the power station during slack time. He saw the first installation of this kind about eight years ago in a suburb of Turin. There were two small Stassano furnaces of 100 h.p. each, and two of 1,000 h.p. each, both taking their current direct from the town supply. In France the idea is making headway. Just outside Limoges a Keller furnace has just been installed capable of smelting down 30 tons of iron turnings and other cheap scrap per day, and producing 25 tons of high-priced cast metal, in conjunction with dephosphoration or without it, or turning out ordinary cast-iron of high quality when the current is obtainable at a low rate. The furnace occupies a very small space in the tramway depôt, and requires little attendance owing to the provision of ample labour-saving appliances. The current in this case is transmitted from a hydraulic power station to Limoges at 30,000 volts, where it is transformed down to 10,000 and then again to 110 volts to suit the voltage of the furnace. The consumption of current is about 700 to 800 kilowatt-hours per metric ton of metal produced. The first heat would, it is presumed, have to start about midnight, or soon after the peak-load is passed at the power station.

# Education and Industry.

Mr. S. C. Laws (Principal of the Wigan and District Mining and Technical College) recently delivered an interesting lecture on "Education and Industry" before the Wigan Education Society. Broadly speaking, he said, the idea underlying the educational system of our own country has been the training and the development of character, while in the case of Germany the educational aim has been the promotion of efficiency. Our provision for industrial education, whilst it gives opportunity for the cream to rise to the surface, is deficient in two important respects. In the first place it is too select; ignoring, or at any rate failing to reach, the ordinary rank and file, quite three-fourths of the population in fact; and in the second place the conditions under which the training is carried on are for the most part such as to render it extremely inefficient. Our vocational education is carried on almost entirely by means of evening classes. So far, technical education has for the most part been relegated to the fag-end of the day, and in consequence, though in individual cases the most wonderful results are obtained, yet on the whole the accumulated output is inadequate, both from the point of view of the energy expended in obtaining it and of our national requirements. We have unquestionably made a tremendous advance since the passing of the Technical Instruction Act of 1889, and there is every sign that we are even now on the eve of an unprecedented move forward as regards technical education, as with other branches of education. The nation is beginning to regard the native capacity of each individual, like the air he breathes, as existing, not for his own sake only, but for that of the community in which he lives and in which he serves.

In Germany the aim of industrial education has been to make every leader in industry a capable leader, every foreman a proficient foreman, every workman a skilful and industrious workman. The German system as it stands, however, could not possibly commend itself for our adoption, being too rigid, but on the other hand we must note that by reason of its thoroughness this system has produced tremendous results in the few years that have elapsed since its extension to the present scale. As in England, so in Germany also we find a system comprising both day and evening classes, but evening and Sunday classes are relatively only of third-rate importance for the most part there, technical education in Germany, like other branches of education, being in all essential respects carried on throughout the day. Germany has been the pioneer of compulsory day continuation schools. Practically every State in Germany has now enacted that all boys, and in many cases all girls, shall attend such schools during the ordinary hours of employment for not less than six hours per week—usually it is eight hours per week—until 17 or in many cases 18 years of age, after leaving the elementary school at 14. The continuation school leads on to the lower technical school, which is a day and evening school attended by persons between the ages of 18 and 20; attendance, however, is no longer compulsory. A remarkable feature of technical education in Germany is the extent to which the young artisan gives up his employment for a while in order to take a short full-time course of perhaps six months' duration, or longer, in the technology of his trade. Before he is allowed to practise his calling he must acquire his journeyman's certificate, and before employing other workmen it is necessary to possess a "master's certificate," the former being obtainable on the completion of the continuation school course, and the latter after a further period of technical training and practical experience, so that owing to their industrial organisation affecting everybody, from the artisan upwards, there is a very direct incentive to utilise the facilities of the technical school. The middle technical school is a very similar institution, except that it is attended exclusively by pupils from the municipal secondary schools and schools of corresponding grades, pupils who have had no previous technical training, little practical experience, but a good general education. Then, above all is the Technical High School, which follows upon the year of military service and is attended by ex-pupils of the high-grade secondary schools who have remained at school until 18 or 19 years of age. The course at the Technical High School is usually of four years' duration, and is parallel with, but quite distinct from, the University, the latter preparing for the legal, clerical, and medical professions, the former for industry, architecture, and engineering. There are eleven Technical High Schools in the German Empire, exclusive of mining schools, agriculture colleges and commercial academies, and all these are attended by no less than 20,000 students. The total number of full-time day students of 16 years of age and upwards in technical schools in England is less than 2,000, and very few indeed of these are attending courses comparable in standard with those of the German Technical High School, or Polytechnikum, for which the normal age range is 21-25. In the matter of higher technical education, as in continuation schools, we are thus working on an altogether different scale from that which obtains in Germany. In America, even more than in England, applied science finds its home in the Universities alongside pure science and literary studies. Higher technical education is also conducted on a big scale in independent self-contained institutions, often monotechnic institutions, or schools organised in connection with a single industry, such as the Mining School at Golden, Colorado. Much further down the scale the American system of education is notorious for its development of the "Works" school. There are part-time schools provided by certain large firms (mainly engineering) for training their apprentices. Schools on the same lines have been provided by the British Westinghouse Company in Manchester and by Messrs. Cadbury at Bournville.

In England one of our difficulties in the past has been that some of our manufacturing firms, having had little or no experience of the highly trained man, have not sought after him, but on the contrary have expressed a decided preference for the purely "practical man." The practical man, said Disraeli, practises the errors of his forefathers, and this is what practice unsupported and unguided by theory is bound to involve, though theory without practice is equally unavailing in industry. On the other hand, the University has undoubtedly gone about with its head in the clouds, and has neither studied the manufacturer nor his needs adequately. Universities and industry have for the most part lived their lives apart, with the result that the University graduate, unless he happens to have proprietary interests, has not prepared himself for industry, but for a profession, with the further consequence that when a firm has occasionally required a really well-trained man they have often been obliged to import one from Germany or America.

Mr. Laws then outlined three possible courses open for technical education. First, by a part-time course, or by evening classes. Secondly, there was the technical knowledge gained by taking a one, two, or a three years' course at a technical school specialised according to the occupation decided upon. Thirdly, there may be two years' employment, followed by a full-time course of from one to four years, the pupil having attended part-time classes during the period of employment. This course has everything to recommend it. A modified procedure, known as the "sandwich system," is being fairly extensively adopted by engineering firms on the North-East coast, and in a less degree in connection with the Wigan and other mining courses. In this plan periods of study and works' experience alternate with one another, so that the youth spends the winter months in school, spring and summer at the works, and so on throughout the apprentice life.

# Foundry Troubles.*

By T. W. Aitken.

Foundrymen's troubles may be classified in three separate groups :—(1) Those which are attributable to the forces of gases and steam; (2) those caused by the force of contractions; (3) those arising out of the different properties of the various constituents of the mixture.

The chief troubles which come under (1) are blow-holes and scabs, both of these (in the case of grey cast iron and brass) are the result of the presence of steam or gas, which has overcome the pressure of the molten metal whilst being poured into the mould. It becomes necessary then to locate the source of such steam or gas and to reduce the quantity to a controllable amount by making adequate exits for the steam or gas to freely escape, or in some cases to increase the pressure of the gates. Not only is it necessary to look to the sand of the mould for moisture or as a producer of excess gases, but chaplets, studs, screws and all metal casting-on or casting-in parts must have serious attention, as in the case of chaplets and studs these are invariably almost enveloped in metal, and therefore no exit for steam or gases can be made. It is not to be expected that any moulder would place a chaplet or stud in his mould which was damp or wet, but sufficient notice is not generally taken as to whether it is rusty or not, a good many believing that so long as it is dry nothing will matter. Iron rust—that is red-rust—however, is an oxide of iron with water in crystallisation, and the temperature of molten iron coming in contact with this rust is sufficient to decompose this combination and set free water and gases.

Scabs are the result of gas or steam not having free escape from the mould in the drag side, owing to the mould being rammed too hard and insufficiently vented, or the sand being too damp either generally throughout or in places. Water is converted to steam very rapidly by metal at a temperature of about 1,600 deg. C. suddenly coming in contact with same, as the majority of moulders will know from their experience of metal spilling on to a wet floor. When one has to face the fact that water on conversion to steam increases in volume to the extent of about 1,700 times its original volume, the importance of making ample provision for its rapid escape and the use of as little water as possible in green-sand moulds can be clearly seen. It is much safer to reduce the quantity of water in the sand and add a binder, as gases given off from the binder only expand to about five times their original volume when heated to the temperature of molten iron.

The troubles which come under group (2) include warped castings and cracked castings, these defects being both due to uneven contractions induced by different thicknesses of metal in the same casting, or to the mould or core being too rigid and unyielding to allow of free contraction of the casting.

In the case of light castings, the runner often has the effect of making an evenly-constructed casting behave like an uneven casting, by adding and retaining the heat at one particular part. The total contraction under normal conditions is fairly constant for a given grade of metal, so that allowance for sizes can be easily made for contractions whilst making the pattern; if this result is not obtained, then one may confidently look for blow-holes or some such defects.

As it is not practical to make all patterns of a uniform thickness throughout, it is for the moulder to so apply his knowledge in the making of such castings that it will behave like a regular and uniform casting. To do this he has to remember the following properties of cast iron.

If non-phosphoric grey iron is being made, immediately after the metal has come to a semi-solid state, i.e., about 1,140 deg. C., it expands, after which it commences to contract again, expanding when its temperature falls to about 695 deg. C.; after this it will continue to contract until it is at normal temperature. Therefore if some part of the casting reaches these varying temperatures at a different period to other parts of the casting, it is quite clear that one part may be contracting whilst another part is expanding, or has ceased to do either and is rigid and unyielding; with the result that a crack may be developed or the casting (if a light one) may be warped, and if neither is revealed then a serious plane of weakness must occur immediately between the separate centres of contraction.

A casting of uniform thickness and structure will contract towards its one centre, but a casting that is not uniform will have more than one centre of contraction, hence, each part of the casting having its separate centre of contraction, will be drawing away from another part. These facts are almost sufficient to condemn such section as impractical if such were the only action of the metal; but one point must not be overlooked, that is, that metals generally are good conductors of heat and therefore we may expect that one part of a casting will conduct its heat to another part and so keep a more uniform temperature throughout the whole casting.

Again, when a moulder is given a casting to make which must have extreme varying thicknesses, he resorts to the method of conducting away the heat from the heavy part by the aid of chillers. If the contrast in thickness is very great he uses a deep cast-iron chiller, whereas if not so extreme he uses a lighter chiller, his reason for so doing being that the heavier the chiller the more heat will it absorb and conduct away into its own mass and the quicker it will act; and a light chiller will not require so much heat before it will become itself the same temperature as that part of the casting to which it is in contact and will therefore then cease to conduct heat from the casting.

A heavy casting will show less total contraction than a light one made of the same metal, yet when dealing with one casting which has both heavy and light parts, one is led to believe that the reverse is the case. Take, for instance, a plate, say, 24 in. square, the pattern of which is perfectly flat on the one side, but thicker at the edges than in the centre; place the runners to cast this on the edges,

* Read before the Newcastle Branch of the British Foundrymen's Association, February 24, 1917.

and the result will be (if no part is aided in its cooling by stripping or any other method), the casting will turn out with the centre bellied or bulged, or if this is not the case the edges of the casting will open up, thus indicating that the heavy part shows a greater contraction than the light part. By reversing this order and making the centre heavy and the sides light, and running this casting in the centre with flat gates, the edges will twist very badly or the centre of casting crack and open. The explanation of this is that the lighter part cools first, and so contracts sooner than the heavy part, but at the temperature at which the first contraction takes place (supposing this casting to be made of grey iron) the metal is in a condition to yield to a tension without revealing any weakness, and so stretches out to remain the same length as the heavy part; and when the light part cools down to the temperature at which the second contraction takes place, the heavy part may be contracting for the first time. The whole casting, if examined at this stage, may be found to be perfectly straight and flat and showing no warping. The light part may now be considered to have practically completed all contractions, but the heavy part has still one period of contracting to make, and in so doing buckles up the light part, if that part is thin enough to yield; or, if not, then the heavy part will crack and complete its contraction to two centres.

The chief of the troubles which come under group (3) are segregations and porosity. It is well known by foundry-men that cast iron is a mixture of iron with other metals and non-metals. The carbon, silicon, manganese, phosphorus and sulphur (these being the chief impurities in iron) do not all exist as free elements but in a state of combination one with another, forming compounds. These compounds have properties entirely different from their separate elements, and the physical properties of the cast iron depend upon the completeness with which these substances mix with each other, and remain so until the casting has reached that temperature when no further changes can take place, and not upon the individual percentages of the elements in the mixture.

If these substances were all completely soluble and no separation occurred, then segregation would not be classed as a foundry trouble. Such, however, is not the case, as some of these substances only remain in solution whilst the mixture is at a high temperature; after the temperature has become reduced they separate out, the total amount of such separation being governed by the time taken in cooling. Quenching arrests this separation.

These separations must be considered as being in two distinct forms:—(1) Those which separate from the solution and become solid before the bulk of the metal (i.e., which have *high* melting points); (2) those which remain liquid as the bulk of the metal solidifies (i.e., which have *low* melting points).

Carbon comes under the former, and the compounds of phosphorus under the latter. When cast iron is in a perfectly molten condition all the carbon is in solution (and would remain so if the temperature of the metal could be maintained), but in cooling the graphite separates out, and, being a light substance, floats to the top of the molten mass, this continuing so long as the metal is sufficiently fluid. When the metal has reached that stage when it is in a spongy form the graphite has no longer free motion, and therefore becomes intermixed with the mass; the size of these particles of graphite depends on the rate of cooling.

Certain compounds of silicon promote the decomposition of the carbide and lower the saturation limit, thus promoting the formation of graphite. This produces open-grained castings (if of a fair thickness) if not arrested by quenching. Therefore to obtain close-grained non-porous castings the silicon content must be low.

Phosphide of iron is the most fusible constituent of phosphoric cast iron, and consequently lowers the melting point of the metal containing it. As the temperature of the metal falls, the excess of phosphide forms with the other fluid portions of the metal, a liquid which has a very low melting point; this liquid will continue to deposit some of the constituents with a higher melting point, so that the remaining liquid will become high in phosphorus and remain molten until the final solidification. Consequently it will occupy middle areas in the course of solidification of the casting, and finally on complete solidification be in the form of a meshed network, known by foundrymen as segregations.

With non-phosphoric cast iron segregations occur, especially if the section of the casting is favourable to slow cooling; but these segregations are not so pronounced and difficult to overcome as in the case of metal high in phosphorus. Cast iron being an alloy composed of several constituents which have various freezing points, there must be one or more of these constituents remaining in a liquid state after others have become solidified; therefore, if the casting is a heavy mass and so cools slowly, this most fluid constituent will be concentrated in one part of the casting, naturally about the centre of the same, as the casting will cool from its outside surface.

I have found in different shops that the amount of pressure in a mould and how it is distributed is not thoroughly understood, and consequently castings are lost which might have been saved if a thorough knowledge had been obtained. When we consider pressure in moulds we must necessarily regard the metal as being a liquid when such is in a molten state, and subject to the law of liquids it transmits pressure to every part of the mould into which it is poured; and each part of the mould, when it is full, sustains a pressure equal to the weight of a column of metal, reaching from such part to the upper surface of the running basin.

By means of model patterns the lecturer then proceeded to explain the application of hydraulic laws to pressure in moulds.

### Discussion.

Mr. M. Gallon said the lifting pressure in a mould which the lecturer had described seemed "a little bit out of it." The lecturer gave about 4 cwt. as the lift upon the top box of a 12-in. cube. He would like to know if that lift would be varied if the cube was run from the top instead of the bottom. His (Mr. Gallon's) method of getting at the lift on a box was to multiply square feet on the casting by the head and then by 40. That gave the lbs. of pressure on the top of the box. He also asked what brand of metal Mr. Aitken ran his small work with.

Mr. Aitken, in reply, said, in regard to the question of lifting in the mould, the bulk of the

gate, or head, had no material effect upon the pressure of the mould. It would not make any difference whatever to the pressure, because it would not create any upward pressure. That was, of course, so long as the metal was in a molten state. After that it did not affect it. With regard to the kind of metal, he always used No. 3 Wellingborough, a very soft metal, and worked the cupola at 10½ to 11 ozs. pressure.

Another speaker asked the lecturer whether the speed at which the metal was run had any effect. With regard to segregation, how could one distinguish, say, a segregation of carbon from the common thing they were all so much troubled with in the foundry—dirt?

Mr. Aitken replied that the momentum at which the metal was poured had no effect one way or another. With regard to distinguishing between carbon and dirt, if one took a casting of fair thickness, which would only cool slowly, and found anything in the centre when examining it with a microscope—black spots and sponginess—one might be certain it was not dirt, because dirt would float on the metal away from the centre. He had, however, found dirt an inch down in the casting, and could not explain it. It might have just got trapped there as it was floating from the bottom. Segregation was always found in the centre of the casting, that part which would be expected to cool last.

At the close of the discussion Mr. Aitken was cordially thanked for his Paper.

## Electric Resistance Furnace for Melting in Crucibles.*

By H. C. Greenwood, D.Sc., and R. S. Hutton, D.Sc. (Sheffield).

A few years ago the authors carried out a series of experiments, with the object of improving the quality of a range of nickel-silver alloys currently produced at their works for subsequent rolling into sheet metal. In the electro-plate trade up to two-thirds of the sheet metal is returned to the melting-pot as scrap, and any fresh nickel required in the melting charge is previously alloyed with copper. Observation showed that the properties of these alloys were greatly influenced by impurities. Bearing in mind the necessary utilisation of scrap, it is obvious that any contamination due to the fuel, e.g., sulphur, would tend to be cumulative. It was found that in these respects gas offered advantages over coke, but also had its disadvantages, some of which it is hoped are overcome by improvements in the furnaces, as described by other authors.

With the desire to be able to melt the alloys under more perfect conditions, the authors decided to make experiments with an electric furnace of the resistance type large enough to take the usual 100-lb. crucible. As regards the type to be employed, the authors were influenced by the consideration that it is often necessary to make different grades of nickel silver in rapid succession; a furnace of large capacity or one which requires metal to be left in it, as the induction furnace, would therefore be unsuitable. Further, in order to avoid the high current required for a cylindrical resistor, a resistance consisting of carbon rods connected in series seemed the most suitable for experimental purposes. Sixteen carbon rods of 1-in. diameter and 19-in. length were arranged in a 13-in. circle, and connected by means of graphite blocks alternately at top and bottom to form two parallel sets, each of eight rods in series. Current was supplied to the two sides of the circle by means of graphite rods ground into holes in two bottom blocks diametrically opposite to each other, the carbon rods making an electrical connection in the same way. The graphite rods were soldered into water-cooled terminal blocks, on to which the supply cables were bolted. To protect the carbon rods from oxidation a mixture of carborundum fire-sand and sodium silicate solution was pasted round them. Owing to an insufficient supply of carborundum fire-sand, the heat insulation of the furnace consisted entirely of kieselguhr, which is not very refractory, and was rather badly shrunk near to the resistors, which probably somewhat lowered the efficiency of the furnace. A better method of heat insulation would be to form an inner layer consisting of carborundum fire-sand or ordinary sand, and an outer one of kieselguhr. The carbon rods would be encircled almost completely by suitably shaped carborundum bricks, only a narrow slit being left to be filled up with the paste, which on large surfaces tends to drop out. In this case there is the advantage of the high thermal conductivity of carborundum bricks serving to equalise the heat generated in the resistors. The importance of good thermal conductivity of refractories is often overlooked. Actual tests carried out with a charge of 90 lbs. of nickel silver took 3 hours and 1 hour 35 mins. for the first and second heats respectively, while the energy consumptions were 53.6 and 29.2 kw.-hrs. respectively per 90 lbs. of metal melted, the voltage varying between about 70 and 60, and the current between 200 and 310 amps. in the first and 280 and 300 amps. in the second heat. On the basis of five heats per day, and assuming the last three heats to require the same energy consumption as the second, the energy per cwt. cost, at 0.8d. per unit, 2s. 10d. Although this is rather high it would be largely compensated by the greatly increased life of the plumbago crucible, which after several heats showed practically no change in appearance, while crucibles heated in gas furnaces flake very badly. Remembering that one could probably increase considerably the efficiency of the furnace, the cost of electrical melting would seem to be not prohibitive, at any rate for special qualities of nickel silver used for difficult spinnings, etc., which demand the highest possible ductility. The actual thermal efficiency in the furnace was about 22 per cent., as compared with about 6 per cent. in the case of gas heating.

The further development of the furnace was postponed, owing to the difficulty of obtaining carbons in this country at present. A description of the work in this incomplete form is, however, given with the object of encouraging others to devote their attention to the development of a commercially practicable electric furnace.

* Abstract of Paper read before the Institute of Metals, March, 1917.

The workmen and staff of the Jarrow and Hebburn establishments of Palmers Shipbuilding & Iron Company, Limited, have contributed by weekly contributions since the war commenced the sum of £19,000 to war relief funds, the amount for the week ending May 19, 1917, being £111.

# Ideals and Limitations in the Melting of Non-Ferrous Metals.*

By Carl Hering.

The purpose of this Paper is to summarise some of the ideals and limitations in the melting of non-ferrous metals, which should be borne in mind in endeavouring to improve present methods. The directions to which perfection points are, to reduce (1) the loss of heat, (2) the loss of metal, (3) the number of bad castings, (4) the consumption of equipment (crucibles), and (5) the cost of labour and plant per lb. of good castings. As these are not all independent factors, economy may sometimes result from increasing some if others are thereby much reduced; thus, increased plant cost may save more in labour cost, and an increase in bad castings might even be warranted by the great saving of heat and labour due to working faster. The best combination of these economies is, therefore, not always a simple matter to determine, and varies greatly with the local conditions.

One of the first things to bear in mind in all high-temperature thermal operations is that insulation against loss of heat is, in practice, at best very poor. Hence, as long as the metal is hot, just so long will this loss continue. But these losses depend not only on the insulation, but quite as much also on the length of time during which they take place, so that reducing the duration of these losses reduces them in proportion. To obtain economy in heat, therefore, the ideal is not only to insulate as well as practicable, but also to heat and cast the metal in as short a time as practicable. If, for instance, it takes two hours to heat and cast a certain amount of metal, then each lb. of the metal loses heat during nearly two hours, while if this same amount of metal could be heated and cast in, say, four instalments, each in half an hour, the heat losses per lb. of metal would thereby be reduced to one-fourth, other conditions being at this point assumed to be the same. It is the total loss of heat per lb. of metal while it is hot which is the criterion.

From this standpoint the most perfect melting furnace is the electric fuse, in which the intended result is completed in such an exceedingly short time—a fraction of a second—that the heat losses during that time are vanishingly small. With fuel heating, too great a rapidity of heating involves higher chimney losses, hence a limit to the speed is soon reached. With electric arc heating there are high radiation losses from the arc, and from at least one, and sometimes both, electrode tips, as the arc must necessarily be kept above the pool of metal. But, in heating the metal by its own resistance, the heat can be generated below the surface, in the metal itself, thereby eliminating all heat transition losses. Neither chimney losses nor those due to radiation from the originator of the heat, then exist; there are therefore none of these restrictions, and extremely rapid heating becomes possible, being limited only by the size of the heat-generating capacity which one is willing to provide; and in the case of brass or zinc, by the volatilisation of the zinc in the part in which the heat is set free.

Although the heat losses per lb. of metal are reduced by shortening the time that the metal is hot, and for this reason small high-speed furnaces would be more economical, the larger the amount of metal in a furnace the less the *rate* of heat loss per lb., *i.e.*, the loss per minute or hour, because with a large body of metal there is less surface per lb. which is exposed to heat losses than in smaller ones. For instance, in a large furnace with a hemispherical hearth, the heat loss per lb. of metal, through walls having uniform insulation, is reduced to about one-half when the capacity is increased from 1 ton to 10 tons, and again to about a quarter when the increase is from 10 to 50 tons. Hence, for this reason, the larger the furnace the better. In fixing the size, therefore, we must bear in mind the following points:—(*a*) When melting is the only object, the metal should be kept hot the shortest possible time, hence there should be used as small a furnace as is consistent with the amount of metal required for one casting. (*b*) When there is involved refining, mixing, uniformity of alloying, the taking of specimens for analysis while melted, or any other operation requiring time, then the larger the furnace the better. At the writer's suggestion a large foundry which casts wire bars is now melting tons of metal in a small electric furnace only large enough to hold a little more metal than for one bar.

Concerning insulation against loss of heat, the thicker the insulation the better, but the outside surface, from which the loss takes place, also increases rapidly with an increase in thickness of the furnace walls, at least for the smaller capacities. Hence a thickness is soon reached beyond which it is practically useless to go. As regards the shape, an approximate hemisphere is the nearest practical approach to the ideal for a furnace hearth. While the thickness of the insulation is of importance, the outside surface seems to be a more important factor than is generally supposed. White-washing is a simple matter, and the fact that experienced foundrymen sometimes do this for their own comfort shows that the additional surface insulation produced thereby must be appreciable. Another practicable method would be to cover the outside with several superimposed layers of thin sheet-iron with the natural polish obtained in their final rolling. Each of these surfaces would add its surface resistance. Heating the outside of a furnace with a cheap fuel is another method, and has been patented. Over-insulation is also possible, because the checking of the flow of heat will cause the furnace temperature to penetrate more deeply into the interior of the walls, and this might cause trouble. Hence water-cooling must sometimes be resorted to in order to guard against over-insulation.

Superheating of the metal is one of the important causes of waste of heat, and, with zinc alloys, there is, in addition, the loss in the volatilisation of some of the zinc. Often superheating is merely done to

* Abstract of Paper read at the recent meeting in London of the Institute of Metals.

supply the heat lost in transit from the furnace to the moulds, and heat could therefore be saved by lower superheating, with a saving in furnace lining, crucibles, zinc, etc. The best way of doing this is to cast directly from the furnace into the moulds. If the moulds are of metal they may readily be brought to the furnace, and if made of sand the casting can be done, without jarring them, either by floating them on a water-channel or by mounting them on a sort of carrousel. With a small high-speed electric furnace it would not be impracticable to bring the furnace to the sand moulds. Heating the moulds, especially when made of metal, also saves some heat, as it then costs less for heat than if it be supplied at high temperature from the superheat in the molten metal. Superheating may sometimes be done more economically by heating the stream of metal while it is being poured out of the furnace into the moulds. This might be done by powerful blast flames along a prolonged channel, or electrically by causing the metal to flow through a carbon or graphite tube heated by resistance, or by passing a large, low-voltage electric current directly through the flowing stream.

Superheating is sometimes resorted to for refining purposes; by making the metal very fluid the impurities will rise into the slag or dross. It is an expensive way, but may sometimes be the simplest method. In a certain type of electric furnace this kind of refining is accomplished very rapidly and thoroughly by a peculiar, strong, upward circulation of the fluid metal, produced electromagnetically. Ingots cast from scrap metal cleansed in this way are preferred by those who remelt them for castings. The dirtiest old scrap metal refined by this "electric boiling" casts into clean ingots with a fine fracture. Melting in a partial vacuum, in some types of electric furnaces, may also tend to produce some refining, as it draws out suspended gases and may reduce the boiling points of some of the impurities enough to eliminate them by volatilisation; but for brasses this would greatly increase the loss of zinc by volatilisation.

The losses of zinc in brass could be reduced in several ways:—(1) By reducing the amount of superheat. (2) By heating only from the bottom so that the volatilised zinc condenses again in the cooler upper layer. (3) By heating under pressure, a method which is possible only in specially constructed electric furnaces.

If a curve be drawn showing the costs of producing a B.T.U. at various temperatures by means of combustion heat, it will be found that the cost rises slowly at first for the lower temperatures, but very rapidly for the higher ones, such as those required in the refining of steel. Too great a draft may supply more air than the fire can heat. With electric heat, however, the corresponding curve is very different, being more nearly a straight inclined line and up to temperatures about double the maximum obtainable by combustion. For the lower temperatures the cost is greater, but for the higher ones it is less. The two curves intersect, hence the cheapest method is to generate the low-temperature heat (up to this point of intersection) by means of fuel, and the higher temperatures electrically. In practice this means preheating the cold metal with fuel heat, say up to, but not above, the point where rapid oxidation takes place, and then melting and superheating the preheated metal electrically.

## Metal Melting.

The following comments upon Papers relating to metal melting, presented at the annual meeting of the Institute of Metals (see our last two issues) are by Mr. I. H. Hall, of the Monometer Manufacturing Company, Limited:—

On the heat control of metals, the speakers omitted to mention that to-day thousands of firms are using a self-acting heat controller in their metal melting furnaces, and also for the heat treatment of metals, muffles, annealing and hardening furnaces; and the same apparatus can be successfully adapted to very high temperature melting furnaces up to and over 2,000 Fahr. At the present time the controller is being designed to regulate a temperature of over 2,000 centigrade.

As to Mr. Hopkins' method adopted at the Mint, if the consumption of gas which he quoted is correct, it is a most serious item, and proves that metal melters should not attempt to devise their own furnace, and subsequently attach a burner arrangement which is not at all in conformity with the design of the furnace. Mr. Hopkins mentioned the surprising fact that the gas flame made a double spiral round the crucible. If a furnace is giving the correct mixture and combustion, neither the spiral nor the gases should be seen. The correct method of using up the gases is by obtaining an incandescent flame.

In regard to the localisation of heat, if metal-melters would investigate this subject they could soon unravel the mysteries and troubles met with in the use of porous, spongy, and indifferent castings. One member mentioned that he had tried gas furnaces, and found that gases entered the metal, and thereby caused spongy castings. If he had investigated the subject he would have found that the cause was the localisation of heat.

It will, no doubt, surprise many users of pot-hole furnaces to learn that the tilting type furnace shows a saving of not less than 3¼d. per cwt. of metal melted in crucible cost alone, besides an enormous saving in labour and other items.

On the question of bricking of furnaces, reference was made to the kind of clay or ganister to be used. The only practical method of bricking a furnace is to employ standardised bricks of not less than 4-in. thickness, and to have the bricks so designed that they will close up in the furnace not more than 1/5,000th for cementing together. Improper bricking is one of the principal difficulties, and the cause of many disastrous results in furnaces, owing to the fact that no consideration is given to the class of bricks.

From experience in the use of oil I have no hesitation in saying that oil-fuel is the fuel of the future for the melting and heat treatment of metals, and this can be fully demonstrated by batteries of furnaces now working. The great difficulty has been, as with gas, the combustion, atomisation, and localisation of heat. There is now on the market a furnace having a combustion chamber, box, and a burner designed in conformity with one another, which are absolutely necessary to attain efficient and economical results. In this furnace an incandescent heat with a non-oxidising flame is obtained—a result hitherto thought impossible. The atomisation and combustion of gases take place first in the combustion box, and finally in the annular combustion chamber of the furnace, with the result that the incandescent heat, which is readily seen in the furnace, rises. There is no direct flame on the crucible.

# Ferro-Manganese and other Deoxodisers.

In the course of a Paper read before the American Institute of Mining Engineers, Mr. F. F. Willcox (of the U.S. Bureau of Mines), summarising the properties of various materials used as deoxidisers, remarks that ferro-manganese is the most prominent and widely used. Added in the form of ferro-manganese or spiegeleisen, or intermediate products, manganese is readily oxidised, and seizes with avidity any oxygen dissolved in the steel as oxide, this property being very strong at the temperature of molten steel. For this purpose it is added in proportions varying between 0.3 or 0.4 to 1.5 per cent.; below 0.4 per cent. the steel is liable to be harmfully charged with oxides. The deoxidising action is usually considered to lie in the greater affinity of manganese than of iron for oxygen, and the consequent seizing by the manganese of the greater part of the oxygen existing as dissolved oxide of iron. Another action of manganese, to which is due in part its value, is its behaviour with sulphur. A further property, which is lacking in the more common deoxidisers, is that it raises the critical temperature to which it is safe to heat the steel, preventing coarse crystallisation at high temperatures.

*Aluminium.*—Aluminium possesses to a high degree the ability to remove traces of oxygen from steel, very small quantities, about 0.05 per cent., "killing" the steel. In itself, it is a more efficient deoxidiser than manganese or silicon, but when considered as the sole means of deoxidising the steel rather than as an ingredient to be used for removing the last traces of gases, there are objections to its use. First, the product of reaction, alumina, is a relatively infusible product. If used in a large amount, therefore, it may give rise to a dirty steel and render the mechanical properties weaker on account of the presence of non-metallic impurities. Second, alumina is incapable of eliminating or changing the condition of sulphur, as does manganese. Third, the use of too much aluminium introduces a tendency to form a larger pipe. The point to be carried in mind is the natural limitation of aluminium as a total substitute for ferro-manganese.

*Silicon.*—Ferro-silicon is effective for removing dissolved oxygen, even when added in proportions as small as from 0.1 to 0.2 per cent. by weight of the steel. It reduces honeycombing, is said to diminish segregation, and to increase the solvent power of the metal for gases. A large pipe is formed in ingots when ferro-silicon is used in excess. Another drawback is that the products of oxidation may remain in the steel should the reaction end product be silica rather than a silicate. An experiment is recorded where ferro-manganese was reduced by 50 per cent. and ferro-silicon increased in varying percentages in an endeavour to economise in the cost of manganese additions, but with the result that the metal was honeycombed and permeated with inclusions of slag. Ferro-silicon finds its most effective use in the foundry rather than in the steel works.

*Titanium.*—Ferro-titanium is given an excellent rating as a deoxidiser by some authorities, but is far from recommended by others. It is said to increase ductility, to prevent honeycombing and segregation, and to remove both dissolved oxygen and nitrogen. The removal of nitrogen is without question, and since the removal of all gases is necessary to obtain sound steel, there is no doubt of the worth of an element that will remove nitrogen. Titanium does not freely alloy with iron, but is more likely to be found as microscopic inclusions in the form of nitride or carbide. When used alone it is not an effective deoxidiser, but is used with ferro-manganese to replace appreciable quantities of the latter. With ferro-titanium, as with ferro-silicon and aluminium, the use of ferro-manganese is still essential to obtain a dense workable product.

*Other Deoxidisers.*—In addition to the above materials, many other deoxidisers have been suggested and some have been used. Among these are magnesium, calcium, sodium, vanadium, uranium, boron, and alloys of these with manganese, aluminium, silicon, and titanium. These washes have as a general base the idea that the reaction product should be a slag of great fluidity, so that it will coalesce into globules of sufficient size to float out of the metal. Among these deoxidisers may be mentioned calcium-silicide, ferro-aluminium-silicide, ferro-calcium-silicide, ferro-manganese-aluminium-silicide, and ferro-titanium-aluminium-silicide. In most of these alloys the various elements reinforce each other; they should make powerful deoxidisers, and be pre-eminently suitable for producing homogeneous steel. Whether they actually are suitable is not known; they are playing but a little part in present-day practice. The extent to which thorough study of these and similar possible deoxidisers has been carried is apparently small.

### Scarcity of Manganese in Germany.

The author points out that Germany has relatively scanty resources of manganese within her borders. The facts in the case seemed to be much as follows:—In the year before the war almost twice the normal amount of high-grade manganese ore had been imported from India and Russia. Also, in the spring of 1915, it was reported that stocks of manganese ore had been confiscated at French and Belgian plants. During the past year piles of slag from old ferro-manganese furnaces in Westphalia, running from 5 to 14 per cent. manganese, had been drawn upon, and the United States Consul Albert, of Brunswick, Germany, reported that the village of Adenslidt had been demolished to secure manganese ore running about 22 per cent. manganese. Lately, complaint was reported from Dutch sources in regard to the quality of German steel. It was said that the steel was daily proving worse, and was becoming hard and brittle. The deterioration was attributed to lack of skilled workmen and to the scarcity of manganese.

### American Manganese.

In America, continued the author, it may be estimated that the average consumption of ferro-manganese for the years 1912, 1913, and 1914 runs about 19 lbs. per ton of steel. This is deduced by estimating that 30 per cent. of the Bessemer production for these years is recarburised and deoxidised by spiegel instead of ferro-manganese. Applying the same estimate to 1916 on 44 million

tons of steel, we have as the indicated consumption of ferro-manganese :—

| | | |
|---|---|---|
| 44,000,000 × 0.75 | = | 33,000,000 tons open-hearth steel. |
| 44,000,000 × 0.24 | = | 10,560,000 tons Bessemer steel. |
| 33,000,000 + 10,560,000 | = | 43,560,000 tons steel requiring manganese additions. |
| 43,560,000 × 19 | = | 827,640,000 lbs. ferro-manganese. |
| 827,640,000 + 2,240 | = | 369,400 tons ferro-manganese requirements. |

Such an estimate is a crude approximation, and the indication of a deficit of 100,000 tons of ferro-manganese is, of course, not borne out by the market price at the present moment. Inasmuch as the method of approximation is applicable to normal years, the apparent deficit shows that unusual economies are being exercised in the use of 80 per cent. ferro-manganese. Intermediate products, between 20 and 80 per cent. manganese, ferro-silicon, silico-spiegel, and special deoxidisers are being used liberally, so that the apparent lack of ferro-manganese shown in the above analysis is compensated for by these substitutes and economies. No deposits of rich manganese ore that hold any promise of furnishing the needed quantities of this material have been developed to date in America. Were war to break out with a first-class Power capable of controlling in part or entirely the high sea, the American situation would be precarious, for no nation can defend itself without steel. Assiduous efforts to discover manganese ore in the country have been unavailing. To be dependent upon manganese is dangerous. It is to be hoped that metallurgical science will discover a substitute.

**FOUNDRY MECHANISM.**—Manufacturers have had a splendid opportunity during the present great crisis to develop their plants to meet the great demand for war material, and also to be in the running afterwards with Continental foundries for machine-made castings. The writer has visited a good few foundries lately, and has been surprised to find that whilst they have all the latest machinery for machining castings, little, if anything, has been done to increase the output in the foundry. Many masters think that all that is required is a pattern-plate, so that all castings shall be alike, and that the question may stop at that. A simple casting may be taken to illustrate how it should be done—a hand-grenade in cast iron. Nothing could be more simple for machine moulding than this, but to get the most out of it one must not let one man do all the operations, viz., moulding, core-laying, casting and opening boxes. A simple power moulding machine does not cost any more than a capstan lathe. It should be a machine with table to hold two 12-in. by 10-in. moulding plates on it. By using two pattern-plates for one job, i.e., cope and drag, one can make a complete mould at one operation of the ram, the pattern plates being fastened to the table of the moulding machine side by side, to prevent slipping about. The writer has had no difficulty whatever in training unskilled labour to work on these machines, and by the end of the week their average number of boxes per day was 300. A man or youth making this number do nothing else but make moulds, youths laying cores and special men pouring the moulds and labourers opening boxes. Core-making for this number is a big question, but can as easily be got over by the adoption of the knife-edge core-box. When using this core-box under an ordinary hand press, girls soon become efficient to turn out 2½ to 3 gross of cores per day, and as each core makes two castings the extra expense of the core-box is soon paid for. One thing must always be remembered; everything must be finished off nice and smooth, and all boxes must work sweetly on the plates, no shackle and no lightness, as it is far better to knock out the mould than let a man try to patch it up. Female labour can do, and is doing, all the above, except pouring the moulds, in a few foundries. Why not a large Government foundry to make the whole of them?—"Tee Bee."

# The Iron and Steel Institute.

The Annual Meeting of the Iron and Steel Institute was opened in the House of the Institution of Civil Engineers, Great George Street, Westminster, on Thursday, May 3, Sir William Beardmore, Bart. (President), occupying the chair.

The Council's Annual Report stated that there were 49 new members elected during the year 1916, and the total membership of the Institute on December 31 was :—

| | |
|---|---|
| Patron ... ... ... ... ... | 1 |
| Honorary Members ... ... ... ... | 6 |
| Life Members ... ... ... ... | 64 |
| Ordinary Members ... ... ... | 1,801 |
| Total ... ... ... ... | 1,872 |

The Council have had occasion to offer their congratulations to several members who have received new appointments or have otherwise had honours conferred upon them. The Duke of Devonshire, K.G., Past-President, has been appointed Governor-General and Commander-in-Chief of the Dominion of Canada. Lieut.-Colonel Maurice L. Bell has been created a Companion of the Order of St. Michael and St. George, and Sir George T. Beilby, F.R.S., has received the honour of knighthood. The Order of the Companion of the Bath has been conferred upon Captain Riall Sankey, and on Colonel N. T. Belaiew of the Imperial Russian Artillery. Colonel W. F. Cheesewright and Major M. G. Christie have both been honoured with the D.S.O., and Lieutenant Lucien Arbel (Lieutenant of Artillery in the French Army) has received the "Croix de Guerre avec Palme" for distinguished conduct in the field.

### Appointment of Technical Committees.

As announced at the autumn meeting, the question of the more efficient organisation of the work of the Institute has been under the careful consideration of the Council during the past year, and it has been thought that the effective co-operation of the members in the work of the Institute might be increased by the appointment of a certain number of Technical Committees to advise as to subjects of practical interest to the iron and steel industries, on which the Council can organise discussions at general meetings, or which may require investigation and research. Five such Committees have been formed, their names and constitution being as follows :—

(1) *Ores, Fuel, Refractories.*—Messrs. W. H. Hewlett and R. Armitage, Dr. W. A. Bone, Messrs. A. Hutchinson, Cosmo Johns, and Myles Kennedy, Professor H. Louis and Mr. W. Thorneycroft.

(2) *Blast-Furnaces.*—Sir John Randles, M.P., Messrs. A. Anderson, P. Cooper, A. Crooke, L. F. Gjers, J. H. Harrison, W. Hawdon, G. Hedley, W. S. Hill, A. Hutchinson, G. Jones, A. Lennox Leigh, H. Preston, A. K. Reese, and T. B. Rogerson.

(3) *Steel and its Mechanical Treatment and Ferro Alloys.*—Messrs. C. J. Bagley, A. Lamberton, M. Mannaberg, Vernon Abbot, W. F. Beardshaw, H. Brearley, P. B. Brown, D. F. Campbell, A. J. Capron, J. J. Cohade (Le Creusot), F. W. Cooper, E. Crowe, J. H. S. Dickenson, E. C. Greig, D. M. Maclay, J. MacFarlane, George Ritchie, E. H. Saniter, W. Simons, and J. Williams.

(4) *Iron and Steel Foundry Practice.*—Sir Robert A. Hadfield, Messrs. G. N. Cook, W. J. Dawson, J. E. Fletcher, A. Putnam, W. Shaw and H. B.

Toy, Professor T. Turner, Messrs. S. W. Williamson and H. J. Yates.

(5) *Metallography, Chemistry, and Physics.*—Dr. J. E. Stead, Dr. J. O. Arnold, Mr. H. H. Ashdown, Dr. T. Baker, Mr. C. O. Bannister, Dr. H. C. H. Carpenter, Dr. C. H. Desch, Mr. T. G. Elliot, Dr. J. N. Friend, Dr. W. H. Hatfield, Dr. H. M. Howe, Messrs. E. W. Jackson, E. F. Law, A. McCance, J. McWhirter, W. H. Merrett, L. B. Milne, D. J. Pinkerton and C. H. Ridsdale, Dr. W. Rosenhain and Mr. D. Sillars.

Four of these Committees have held a first meeting since the beginning of the present year, and plans are in progress for arranging suitable programmes for future general meetings.

### Proposal for New Accommodation of the Institute.

Plans are under discussion for the accommodation of the Institute, jointly with several other scientific and technical Institutions, in one building, with a common meeting-room, library, and reading-room. The Institutions of Mining and Metallurgy, and Mining Engineers, and the Institute of Metals have been approached, and the question of co-operating in securing joint accommodation with these institutions is under consideration.

### Committee of the Privy Council for Scientific and Industrial Research.

A grant of £100 was offered to the Institute by the Committee for Scientific and Industrial Research to meet the cost of preparing for the Committee a statistical survey of the supply of raw material (exclusive of fuel) for use in the iron and steel industries. The offer having been accepted by the Council, a report dealing with the iron ore resources of the United Kingdom and the British Dominions, and with the principal iron ore resources of other countries, as far as information was available, was compiled and submitted to the Research Council in December. A further section of the report referred to the occurrence and production of the ores of other metals used in the industry, such as chromium, cobalt, manganese, molybdenum, nickel, tungsten, titanium, vanadium and zirconium.

### Andrew Carnegie Research Fund.

With regard to the administration of the Carnegie Fund the Council have found that, owing to the restriction imposed on the age of candidates, applications for grants for research work have not been coming forward as freely as usual since the beginning of the war. They therefore communicated with Mr. Carnegie on the subject, who was good enough to reply that he would be pleased to leave the matter to the judgment of those in whose hands the administration of the Fund had been placed, and that he would be satisfied with whatever action the Council might take in the matter needing consideration. The Council thereupon decided to suspend the age limit of 35 for the present, and to modify the scheme under which applications were invited as follows:—

The Council of the Iron and Steel Institute is prepared to make from the Research Fund, founded by Mr. Andrew Carnegie, Past-President, a limited number of grants in aid of research work on problems of practical importance relating to the metallurgy of iron and steel and allied subjects. Applications may be sent in on a special form before the end of March to the Secretary of the Institute.

Directors of Private and Public Laboratories, Principals of Metallurgical Training Establishments, and Managers of Iron and Steel Works, who desire to promote research work on some problem connected with the metallurgy of iron and steel or an allied subject, are invited to submit proposals for a grant for the purpose of such an investigation to be carried out by some qualified person nominated by themselves and working under their supervision.

Independent investigators are also invited to apply for a grant for similar purposes, provided that they satisfy the Council that they are properly qualified to carry out the research work which they propose to perform.

In considering the allocation of grants the Council will be guided by the nature of the subjects proposed for investigation, and will give preference to those which, in their judgment, appear to be of the most practical advantage to the iron and steel and allied industries.

### Bessemer Medal.

The PRESIDENT said it was now his pleasant duty to present the Bessemer Gold Medal to Mr. Andrew Lamberton (Vice-President). Mr. Lamberton was well known to all the Members as the head of the firm of Messrs. Lamberton & Company, of Coatbridge, and his work in connection with the iron and steel industry had been mainly in the direction of the development of the principal mechanical engineering appliances in use in the manufacture of iron and steel. He ought to explain that this year the form of the presentation differed in one important respect from the form in which it had always been made in previous years. Mr. Lamberton had, for patriotic reasons, foregone the acceptance of a medal struck in gold, and the Institute was consequently presenting to him at present nothing more than the diploma to which the usual metal replica of the medal was attached. The Institute was asking Mr. Lamberton to accept that in token of their recognition of his eminent services in the development of mechanical engineering as applied to the manufacture of iron and steel, and would look forward to the time, at no distant date, when they would hope to supplement the parchment with the real object.

### Carnegie Research Fund.

The SECRETARY announced that awards had been made by the Council from the Carnegie Research Scholarship Fund to the following:—Mr. W. C. Hancock, £50, to enable him to continue his investigations on refractory materials, with special reference to the manufacture of coke-oven bricks (Mr. Hancock received £100 in 1916 to assist him in carrying out the research); Messrs. J. L. Haughton and D. Hanson, £100 to enable them to continue their joint research on iron-phosphorus and iron-carbon-phosphorus steels (applicants received £100 in 1916 in aid of the research); Mr. J. E. Hurst, £100 for an investigation on the wearing and the microstructure of worn cast-iron specimens; and Messrs. J. H. Whiteley and A. F. Hallimond, £100 for a joint research on the chemical detection of strain in iron and steel.

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**MALLEABLE TUNGSTEN.**—In a U.S. patent recently granted to A. Helfgott, of New Pest, near Budapest in Hungary, it is claimed that better results can be obtained in making malleable tungsten if a mixture of granular tungsten and finely-powdered tungsten is used, than when either of these is used separately. When the mixture is used, the finely-powdered metal acts as a binder in sintering, cementing together the grains of the granular tungsten.

# Furnace Demonstration Shops.

Messrs. Brayshaw Furnaces & Tools, Limited, have recently completed an interesting and important addition to their Mulberry Street Works, Hulme, Manchester, comprising a two-storey shop equipped with the various gas-fired furnaces of which the company make a speciality. So far as we are aware, a shop of this description is a novel departure; it is, however, an innovation which will be generally appreciated by furnace users. Hitherto prospective customers have had, for the most part, to select the furnace to meet their particular requirements from the maker's specification, and possibly also by inspecting a furnace of approximately similar design, though obviously if a manufacturer has hit upon a furnace which shows any marked improvements either in working costs, the results achieved, or a combination of the two, he will not be unduly anxious to assist his competitors.

It was no doubt a consideration of the foregoing which led Messrs. Brayshaw to put down a range of various furnaces which could not only be seen in operation but in which the bulk samples of material could be treated under the direct supervision of the interested party, who would thus have something concrete to influence his selection. The shops were recently visited by our representative. The furnaces installed are generally of the makers' standard type, and for these a few descriptive words will suffice. There is, however, one notable exception in the Brayshaw patent low-pressure regenerative furnace, designated by the makers the "Lopress Regenerative," which seems to mark a new epoch in the construction of annealing furnaces. Whilst its handling and adjustment are of a simple character, a "reducing," "neutral" or "oxidising" atmosphere can be produced at will. The "greasy" flame so essential for much annealing work, and hitherto so difficult to obtain with gas, can be produced to perfection. A view of this furnace is given in Fig. 1.

Gas is used at the ordinary town's pressure and air at 4 in. to 8 in. W.G. pressure, only a fan being required. A special feature of the furnace is the arrangement for pre-heating the air, which is subjected to a true regenerative action, as distinct from the usual method of pre-heating by passing it through passages arranged in the floor and walls of the furnace, an arrangement which, to an extent at any rate, robs the furnace of some of its heat. In the "Lopress" furnace the secondary air is heated solely by the waste gases, only sufficient primary air being admitted with the gas to partially support combustion and cause the gas to burn with a "greasy" non-oxidising flame.

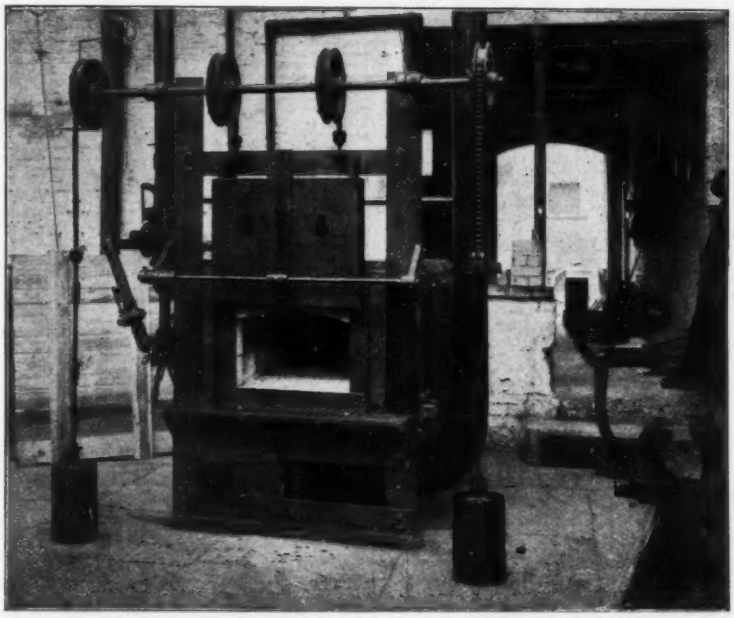


FIG. 1.—FRONT VIEW OF THE "LOPRESS" REGENERATIVE FURNACE.

The gas inlets are provided at floor level on one side of the heating chamber, the waste gases exhausting through ports on the opposite side of the chamber. The exhaust outlets are connected to a longitudinal flue, which is carried the full length of the furnace under the side wall, below the flame inlets, by means of traverse flues which are placed below the floor of the furnace chamber. The pipe for pre-heating the air is placed within the longitudinal flue, this air pipe being connected at one end to a second pipe which supplies the air through nozzles placed below the flame inlets into the furnace. The air inlets for the primary combustion chambers are provided with covers, which can be opened or closed as required to regulate the ad-

mission of air to obtain the particular flame required. It will be seen from the foregoing that the waste gases do not enter the regenerator until after their useful effect in heating the furnace has been exhausted, and that these gases in their passage to the regenerator serve to assist in heating the furnace floor.

It will be further noted that as the burners are not of the Bunsen type the possibility of trouble from "lighting back" has not to be considered, so that it is impossible for combustion to take place in any but the correct way. Records taken of a month's continuous working of one of these furnaces used for annealing steel ingots show the average gas consumption to be only 2,500 cub. ft. per ton of steel ingots annealed.

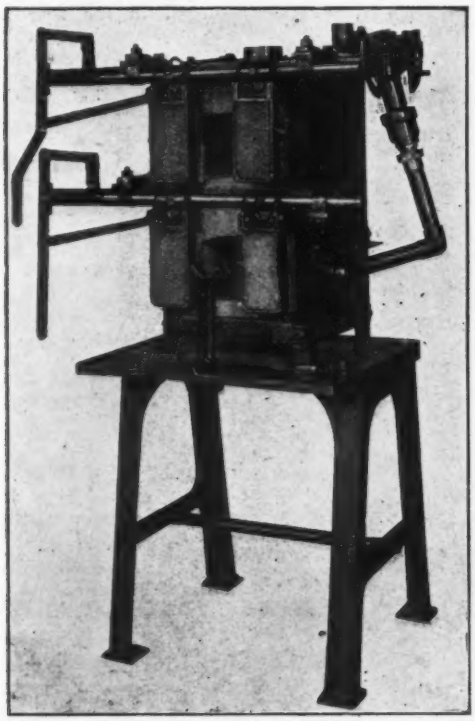


FIG. 2.—TWIN-CHAMBERED FURNACE FOR HARDENING SPECIAL TOOL STEEL.

This furnace, together with a furnace specially designed for testing firebricks and the like, occupies the ground floor of the building. On the first floor are installed (1) the Brayshaw muffle or oven furnaces for hardening, case-hardening and similar operations, for which type of furnace air is supplied under pressure of 1 lb. to 2 lbs.; and (2) twin-chambered furnaces (see Fig. 2) for hardening high-speed steels, etc. The second chamber in this furnace is heated with the waste gases from the first, a very serviceable and economical arrangement for pre-heating tools before finally raising them to the high temperature necessary for hardening. The furnace is worked under pressures of 1 to 2 lbs. The burners are of special construction to avoid the presence of air currents inside the furnace, and they allow the steel to be strongly heated without blistering.

The Brayshaw salt bath furnace (Fig. 3) is principally used for hardening ordinary carbon tool-steel articles, but also for the re-heating of carburised work for case-hardening. The furnace has a rising and falling tray, and has recently been adapted for low-pressure air taken from a fan. There are gas and air taps with large graduated quadrants to allow of accurate adjustment for regulating the supply. There is an entire freedom from complications; the temperature may be raised rapidly from cold and the heat easily maintained.

There are also natural-draft double and single

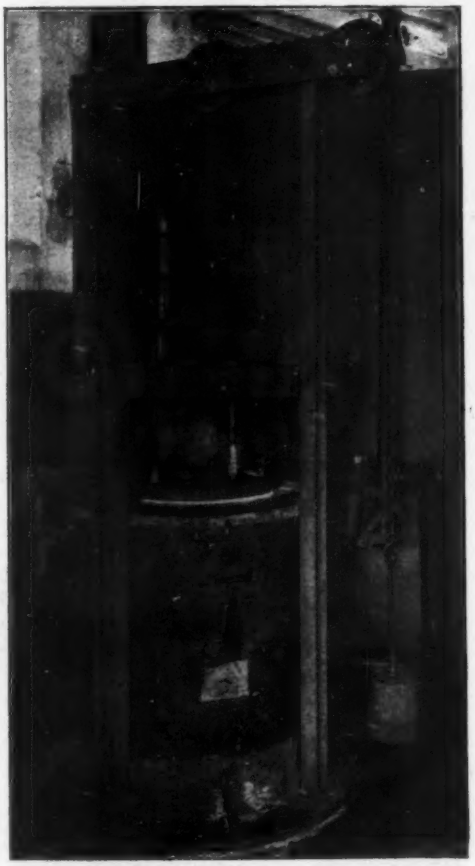


FIG. 3.—THE "BRAYSHAW" SALT BATH FURNACE.

muffle furnaces. In the first-named the temperature in the top chamber is maintained at about 300 deg. C. below that of the bottom one by the waste gases passing from the latter.

With all classes of work in which it is not absolutely necessary to protect the contents of the furnace from the products of combustion, a considerable saving in gas, approximating to 25 per cent., can be effected by the substitution of a tray in place of the muffle, thereby forming what is commonly known as an oven furnace. In conclusion, although the whole of the furnaces referred to are working on town's gas, they can be modified so as to give equally satisfactory results when worked with producer gas.

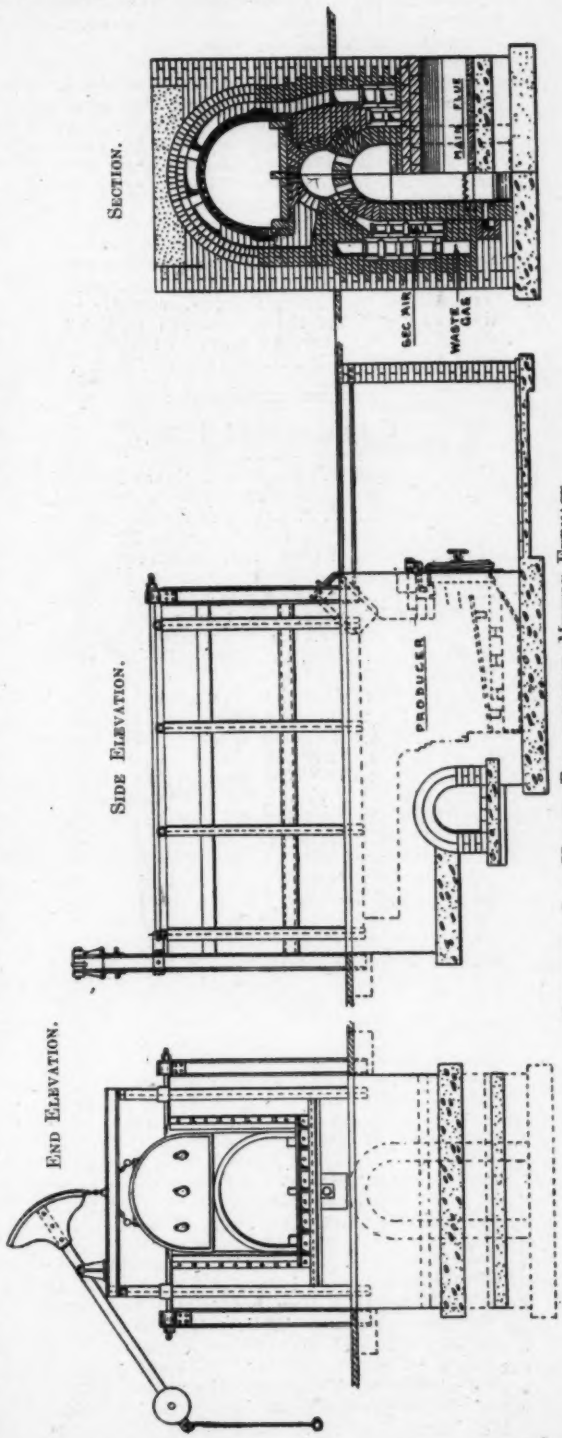
# Coke-Fired Regenerative-Type Muffle Furnaces.

On a recent visit to the Warrington Works of the Richmond Gas Stove & Meter Company, Limited, our representative was able to see in operation two coke-fired regenerative furnaces, designed and constructed by the company's solid-fuel furnace department, and installed in the new enamelling shop for the process of enamelling iron plates, etc. Fig. 1 shows elevations of one of the furnaces. Each furnace chamber measures internally 13 ft. 3 in. deep by 4 ft. 6 in. wide and 3 ft. 3 in. high to the crown of the arch. The work done in the furnaces is naturally of a very exacting nature, as the enamelling process requires dead even temperatures throughout the furnace chamber of 850 deg. to 1,000 deg. C., according to the class of work being treated. The muffle chambers must be absolutely free from sulphur fumes or other injurious gases, otherwise the surface of the enamel would be spoilt. In actual practice dead even temperatures appear to be easily maintained in these furnaces, the muffle chambers being quite free from injurious gases (due to the construction of the muffle walls), and the finished work having a perfect surface. For continuous working the fuel consumption in each furnace is 17 cwts. of gas-works coke per 24 hours.

The design provides for either a close muffle, as in use at the Richmond Company's works; or of the "oven" type in which the products of combustion pass directly into the heating chamber. Each type has its advantages, governed by the process of heat treatment required. The system may be applied to all manner of heating operations, including annealing metal, normalising and hardening, plate heating, billet heating, steel frame bending, melting metals and glass, and enamelling, etc. The coke is fed through the producer charger door at floor-level, and this charging door can be arranged for position at front, back, or sides of the furnace to suit requirements. The coke falls upon angle firebars supported upon heavy cast-iron bearer plates. The producer is of ample area so that a large body of fuel is contained therein, and above the producer chamber arch is constructed a combustion chamber in which the CO produced is led through suitable nozzles. The pre-heated secondary air is also led into this chamber, meeting the CO, forming $CO_2$, and thus producing intense heat. From the combustion chamber the gases then circulate around the muffle, from whence, after doing full duty, they pass away to the regenerators built at each side of the producer.

The secondary air passages, furnished with controlling slides, are built between the producer and the waste-gas flues, thus pre-heating the secondary air to the fullest extent before the same enters the combustion chamber. The waste gases enter the main flue to the chimney at a very low temperature, having given up their heat to the secondary air. The primary air is led on either side of the producer beneath the underside of the angle firebars through suitable passages, which are provided with regulating slides. The producer is also fitted (for the purpose of clinkering) with a perfectly fitting door, thus sealing the producer chamber and preventing entrance of all air except that required and controlled at the primary air inlets.

A water supply is fitted to the producer in such a manner that the water is constantly dripping upon the angle firebars, thus preventing heavy clinker from adhering to them, and also forming steam, which, coming in contact with the incandescent fuel, eventually produces water gas and considerably helps combustion.




RICHMOND COKE-HEATED REGENERATIVE MUFFLE FURNACE.

The secondary air and waste-gas flues are constructed of panelled tiles peculiar to this type of regenerator. The formation of these panels increases the conductivity, and at the same time presents a larger area of heating surface to the gas and air, whilst the method of building up the tiles renders short-circuiting impossible. The air and waste gases do not pass through long tubes or passages, as in most types of regenerators; in this case they are baffled in such a manner as not to restrict their free flow, but at the same time to extract the full duty from the waste gases.

The advantages of the coke-fired furnace may generally be summarised as follows:—(1) Low fuel consumption, showing an economy of from 30 per cent. to 40 per cent. in this respect over the direct-fired coal-heated furnace. (2) Dead even temperatures and soft soaking heats, maintained indefinitely throughout the heating chamber. (3) A reducing or oxidising atmosphere easily maintained at the will of the operator. (4) Flash temperatures (due to careless firing in coal-fired furnaces) are impossible in this type of furnace.

## Cupolas and Iron.

At a meeting of the Newcastle and District Branch of the British Foundrymen's Association on April 28, Mr. W. J. Paulin in the chair, discussion was resumed on the paper by Mr. H. J. Young, "Control of Cast Iron," which appeared in our April issue.

Mr. Wise said that he was under the impression that in his paper Mr. Young expressed the opinion that some of the impurities in iron were altered, or not altered, through good or bad cupola practice.

Mr. Young replied that the phosphorus was altered by the melting. One writer had recently stated that if a ton of iron were put into a cupola they would not get a ton of iron out, because so much was wasted. Consequently there might be the same amount of phosphorus in a less amount of iron. Personally, he thought the quality of the metal was different in every cupola. The hotter the cupola was worked, *i.e.*, the more quickly the metal came down, the stronger would be the metal, because it had not the same chance of absorbing carbon.

The Chairman expressed the opinion that they could get hotter and quicker iron by closing up several of the tuyeres. He quoted a case where he had six tuyeres blowing, and when two were stopped up better metal was got. When he tried the continuous tuyere he had a pressure of about 11 ozs., and merely got the metal warmed.

Mr. Matthew Gallon said that the old-fashioned idea that oxygen could be got to create carbon dioxide if introduced by tuyeres all round the cupola was a fallacy. They got the best results by stopping up the top row. He advocated a liberal use of limestone, because when the limestone was burnt and smashed asunder it liberated carbon dioxide.

Mr. J. Smith preferred the old-fashioned cupola. But he wondered why with two cupolas, which were exactly the same, and using exactly the same iron, results that varied so much were got. As long as he got iron down hot enough and quick enough to cast the work, then he felt satisfied. Some people seemed to rush at saving a bit of coke on a job, but sometimes he thought that was a costly business. He advised the use of a little extra coke to get the metal into good condition.

Mr. Young said that probably the two cupolas which gave different results had been built by men of very little intelligence; they had probably been built in a rough manner. He dared say that if the matter were gone into scientifically they would find that the two cupolas were hardly alike. The only solution he knew was to work the metal according to the cupola, for to try to make the cupola different would be much more costly than to make the metal different. A possible explanation was that those who built the cupolas did not work to mathematical accuracy—they worked to nothing like the same accuracy as the scientific-instrument maker. With regard to the suggestion respecting limestone, that struck him as being incorrect, for the limestone simply liberated the gas and formed the flux, but the gas which was of value came from the air. He did not agree that the old-fashioned cupola was necessarily the best. He would not like to disparage those who were trying to produce better cupolas. At Birmingham they were using 15 tuyeres, and he contended that they were getting better results than anybody else.

Mr. J. D. Carmichael, referring to the Diesel engine, recalled that in the paper Mr. Young had suggested that it would never become a practical apparatus. Could the chemists not give them some information to overcome the difficulty in running the engines? He understood that the metal "grew." Was it not possible to make a mixture of cast iron that would withstand that "growth"?

Mr. Mathews asked what was the safe phosphorus content for iron for Diesel engines. He knew they got nothing more than 0.3 for Diesel cylinders, but some makers had got as much as 1 per cent. phosphorus, and they said it was not harmful at all. High phosphorus, some contended, reduced the expansion of the metal. It seemed to him that they would never be able to get a cast iron thoroughly satisfactory for such work when they bore in mind the extraordinarily high temperatures at which the engine worked.

Mr. Shaw said that as far as he could see foundrymen would not need to worry very much about castings for Diesel engines. They might go on improving, but he did not think they would ever reach the high standard that was expected of them. If engineers kept on improving methods of combustion, and persevered with the greater perfection of the turbine, he did not think that the oil engine would ever supersede the present methods. One thing that was obviously against the Diesel engine was the large units; they could never hope to reach the high units reached at the present time by the turbine. They heard a good deal of the successes of the Diesel engine, but they heard very little of its failures, and if more of the failures were published they would probably get a surprise. The higher efficiency of the Diesel engine was, he considered, swallowed up in practical results.

Mr. J. Smith asked whether, supposing the Diesel engine was a failure, it was the fault of the design of the engine or of the material of which the castings were made. If the engine was right and the castings were wrong then they should try to get the castings right, but if the engine was wrong and the castings were right then not much could be done.

Mr. Shaw thought the failures of the Diesel engines were due to the design, undoubtedly. Up to the present it had been found impossible to get any great power out of one cylinder, or to get the units necessary for big battleships. The Diesel engine would, however, have its use, although it would not be on the sea unless it were confined to small craft.

## Correspondence.

### Effect of Silicon in Cast Iron.

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—I am glad to note that Mr. Adamson tacitly agrees with the main contention I made with regard to his original Paper on the above. The only point I discussed at any length (see paragraph 4 on page 193, to which Mr. Adamson refers) was that of the effect exercised by silicon in converting combined carbon into graphite. It would, of course, be futile to say that silicon does not have this effect, and Mr. Adamson, in his letter, wisely does not attempt to. Whether you would call this effect "controlling the carbons" depends entirely on how you define the word control, which matter I have already gone into fully.

It is an old method in controversy to raise a side issue at a convenient moment in order to confuse the main issue, and here is Mr. Adamson saying that *if* silicon controls practically everything in cast iron (including presumably the mechanical properties), will I kindly explain why there is that wide variation in the mechanical properties in the two tables I quoted? It is surely hardly necessary to say that silicon does not in any sense of the word control the mechanical properties of cast iron. This was an obvious deduction from a consideration of those two tables, and it would be very foolish to think otherwise. Mr. Adamson merely uses a missile with which I have supplied him to knock down a cockshy put up by himself. As to his statement that "Mr. Rolfe has kindly quoted two tables in his intended criticism which easily go against the views of silicon control which he apparently professes to espouse," if Mr. Adamson will re-read my short article he will see that I espoused nothing of the kind. I only claimed that the increase of silicon in cast iron is a factor which tends to convert combined carbon into graphite, but the effect of which may be overruled by other factors. Mr. Adamson will not have it that way. You must be either for him or against him.

The true facts of the case, put shortly, are as follows:—Mr. Adamson very properly has his knife into what he describes as the system of silicon control, according to which system it is apparently by some people assumed that silicon is the only important variable factor in cast iron (i.e., that you have only to vary the silicon and everything else varies accordingly). This claim as regards the effect of silicon is absurd, and in this respect most people will agree with Mr. Adamson.

This point being quite clear, it is now necessary to say that the case against silicon control is quite strong enough in itself. If you are setting out to disprove it, there is no need to make use of arguments that will not hold water, or to argue from the exception instead of the general rule. Mr. Adamson commits both these errors. I do not object to him taking the line that if you are considering, say, tensile strength of cast iron, the effect of silicon appears to be nil and that therefore the effect of silicon on the distribution of the carbon is negligible from this point of view (that of strength). To go so far as he does, however, and to say that silicon does not control combined carbon and its ratio to graphite is wrong. Other things being equal, it does. Other things not being equal, it does not, because its effect *may* be wiped out by the effect of other factors. All this was fully gone into in my note. Mr. Adamson does not controvert any of my arguments one iota. He seeks refuge in general statements, and discusses "the point of view of the practical man" and "terminology." It is impressed upon me repeatedly that it is necessary to get down to the point of view of the *practical* man, the man in the works, and Mr. Adamson clearly does not think that a practical man can possibly be scientific, or a scientific man practical, which is a rather deplorable point of view. In fact, he almost disarms criticism when he suggests "that we have reached the time when true practical progress is necessary, and that it would be better to stop quibbling over terminology or accuracy of expression." I should have thought that accuracy of expression was essential to true progress. Again, I have no desire to set up a fresh system of terminology. Our present one is quite satisfactory if not misapplied. It is quite possible to be both clear and scientific. Being scientific does not necessarily mean only being able to express oneself in words, the meaning of which the average man does not know.

I have every respect for the *practical man* (by which I mean the kind that Mr. Adamson depicts). Let him advance in his own way and express himself in his own way as he likes. My remarks were not directed against those "unscientific practical men" whom it is very difficult to get into the limelight. Mr. Adamson *was* in the limelight. Again, it is not a virtue on the part of the practical man to be unscientific.

Lastly, let the practical man, in "taking a short cut to hard, bare facts," beware lest he land up against "facts" which can only be described as fictitious. It is apparently only too easy.

Yours, etc.,

R. T. ROLFE.

Bedford, May 15, 1917.

### Substitute for Flour.

*To the Editor of the* FOUNDRY TRADES JOURNAL.

SIR,—With a view to economising the flour which most, if not all, brassfounders use to "dust" their moulds before pouring the metal, we are pleased to make it known that we have found wood dust from polishing machines, or *very* fine sawdust, quite equal if not superior to the precious flour (either corn or rice) which is so expensive.

We consider that the use of flour these times for casters' purposes is almost criminal; having this in mind, we shall be pleased, if you think the idea novel, to see that it is made known generally. We have paid as much as 38s. per bag for rice flour; the wood dust is worthless, and can be had for the asking at proper quarters.—Yours, etc.,

BROADHURST & COMPANY.

Walsall.

## Query.

### Facing for Loam-work Steel Moulds.

I should be extremely grateful if any of the readers of your Journal could assist me by giving a composition of facing material suitable for loam-work steel casting. I am in a difficulty over this matter, not having had experience in loam-work (steel). Also information respecting a suitable wash for mould would greatly help.—"E."

## Trade Talk.

THE King has approved the draft of a Charter of Incorporation for the British Trade Corporation.

MESSRS. A. & F. STAGG, steel and file manufacturers, Artizan Works, Penistone Road, Sheffield, have paid a supplemental dividend of 6s. 5½d.

THE NOVERA METAL COMPANY, LIMITED, are being wound up voluntarily, with Mr. S. W. Revill, 20, Eastcheap, London, E.C., as liquidator.

CLAIMS against the late Mr. J. W. A. Spencer, ironmaster, Woodside House, Coatbridge, are to be lodged with Messrs. Somerville & Russell, Airdrie.

MESSRS. J. Hawkins and C. Hawkins, engineers, Severn Engineering Works, Tybridge Street, Worcester, trading as C. Hawkins & Company, have dissolved partnership.

MESSRS. B. SMITH AND W. H. SMITH, engineers of woodworking machinery, Midland Works, Wellington Street, Bingley, trading as B. Smith & Son, have dissolved partnership.

IN order to make provision for future extensions the directors of the Parkgate Iron and Steel Company, Limited, have acquired 144 acres of land close to their works and adjoining the Midland Railway.

MR. J. RAITT, trading as John Raitt & Company, metal merchants and refiners, 32, Mid Street, Dundee, has suspended payment, and has granted a trust deed on behalf of his creditors in favour of Mr. S. Milne, 11, Reform Street, Dundee.

THE partnership heretofore subsisting between Messrs. F. Fleming, L. Horsman, and W. Peach, carrying on business as brass founders and finishers, at West Vale, Halifax, under the style of Frederick Fleming & Company, has been dissolved.

MESSRS. LEON PLAUT, of Moscow, who are the Russian agents of Hadfields, Limited, W. & T. Avery, Limited, and the Stirling Boiler Company, Limited, have established a branch at 40, Granville House, Arundel Street, Strand, W.C. 2.

THE partnership heretofore subsisting between Messrs. W. Reeve and H. G. Reeve, range manufacturers, heating engineers, and ironfounders, 36, Duke Street, Norwich, trading under the style of E. G. Reeve & Sons, has been dissolved.

THE partnership heretofore subsisting between Messrs. F. W. Ratcliff and G. H. Pearson, carrying on business as ironmasters, at the Anchor Iron Works, Oldbury, Worcestershire, under the style of F. W. Ratcliff & Co., has been dissolved.

AFTER standing idle for about twelve years a restart was made recently at the Askam Iron Works, of the Millom & Askam Hematite Iron Company, Limited. At Askam there are four furnaces, one of which has now been relighted. Other furnaces are being rebuilt.

AN order has been made by the Board of Trade requiring the undermentioned business to be wound up:—The London Emery Works Company, Limited, Park, Tottenham, London, N., manufacturers of emery paper. Controller: R. Evans Smith, 53, New Broad Street, London, E.C. May 1, 1917.

A FURTHER stage in the formation of plans for the furtherance of British engineering interests after the war is marked by the decision of the British Engineers' Association to affiliate to the British Empire Producers' Organisation, which now represents an aggregate of over £500,000,000 of invested capital.

THE ALLEN-LIVERSIDGE PORTABLE ACETYLENE COMPANY, LIMITED, of 106, Victoria Street, London, S.W., have purchased the whole of the undertaking and business of their two allied companies, viz., the Allen Company and the A.-L. Meteorlite, Limited. In future the name of the company will be Allen-Liversidge, Limited, but as the three companies have hitherto been carried on practically under the same management, the amalgamation will not interfere with the previous policy of the concerns.

THE partnership heretofore subsisting between Messrs. A. E. G. Braithwaite, J. H. Humphryes and A. Anderson, carrying on business as engineers, at 117, Victoria Street, Westminster, S.W., Daimler House, Paradise Street, Birmingham, the Crown Works, West Bromwich, and Neptune Works, Newport, Monmouthshire, and also at 8, Clive Street, Calcutta, under the style of Braithwaite Kirk, has been dissolved. Messrs. J. H. Humphryes and A. Anderson will continue the business under the style of Braithwaite & Company.

PLANS have been passed at the Glasgow Dean of Guild Court approving extensions at the works of Wm. Beardmore & Company, Limited, Parkhead; Alexander Stephen & Sons, Limited, Govan; Sir W. G. Armstrong, Whitworth & Company, Limited; D. & W. Henderson & Company, Limited; the Fairfield Shipbuilding and Engineering Company, Limited; Alley & Maclellan, Limited; Mechans, Limited; Barclay, Curle & Company, Limited; G. & J. Weir, Limited; and the Govan Shafting and Engineering Company, Limited.

THE Sheffield Master Cutler announces that the appeal for spare razors, which the Cutlers' Company undertook at the request of the late Lord Kitchener, has been very sympathetically taken up throughout this country, and in many parts of the world. Nearly 300,000 razors have been already received, and the appeal has to a great extent fulfilled its object. Supporters of this effort are asked to send forward any razors they may still have in their possession, addressed to the Master Cutler, at the Cutlers' Hall, Sheffield, so that they may be put in order and sent forward to the troops.

SIR FORTESCUE FLANNERY asked the Secretary to the Board of Trade whether in view of the number of patents which, in consequence of the war, had been more or less unworkable, the Government was considering the question of extending the period for which patents were usually granted subject to the payment of fees applicable to the later years of a patent. MR. ROBERTS said the whole question of the amendment of the patent laws had been for some time under consideration, and it was hoped to introduce legislative proposals on the subject as soon as circumstances would permit.

MOST of the engineering and allied works in Luton possess private fire brigades, well-drilled and well-equipped, and to test their relative strength and skill a series of competitions was held at the Corporation Highways Depôt on April 28. Representatives of five firms took part in four events, which were timed and judged by civilian and military experts. The Skefko Company's men won the first and second events, the Commer Cars' the third, and Messrs. G. Kent's the fourth. Gold medals were awarded to the winners, and a £30 challenge cup, to be held as a championship trophy for one year, was carried off by the Skefko Company (chief officer, H. J. Evans), with an aggregate of 34 points; Vauxhall Motors being second with 20 points.

WITH a view of enlisting in greater measure than heretofore the advice and assistance of employers and workpeople in the working of the Employment Exchanges throughout the country, the Minister of Labour has decided to set up advisory committees in connection with each exchange (or small group of exchanges), consisting of persons nominated by associations of employers and workpeople, together with a small number of members appointed by the Minister. These committees will not be limited to the consideration of matters referred to them by the Department, and it is proposed that they shall be charged in due course with important functions in connection with the return to civil employment of discharged soldiers and sailors after the war. In view of the establishment of these new committees, it is not proposed to call together again the advisory trade committees already existing in connection with the Employment Exchanges.

THE NATIONAL LEAD COMPANY, of America, have purchased one-half of the share capital of Williams, Harvey & Company, Limited, who have two plants, one at Liverpool and the other at Hayle, Cornwall.

The purchasers are proceeding with the erection of a tin smelting plant in the United States, which will be operated in connection with the English company. An American company has been incorporated under the name of the Williams Harvey Corporation, to transact the business in the United States. The National Lead Company expend over £2,000,000 a year in the purchase of tin, which they market in the form of solder, type metals, tin pipe, babbitt metals, and other articles. The company have for many years smelted scrap tin and tin drosses. They have also experimented for many years with the smelting of tin ores in the belief that the tin ores of Bolivia, shipped through the Panama Canal, should logically be smelted in the United States for domestic consumption.

The Ministry of Munitions directs attention to the fact (1) that aliens in the United Kingdom may not take up or be engaged for work connected with the production of munitions except through a Board of Trade Employment Exchange; and (2) that it is an offence for an alien to take up such work, or for a firm to employ on such work aliens to whom the Ministry has not granted a permit to work on munitions. These Regulations apply not only to Controlled Establishments, but to all firms engaged on the production of Munitions of War under the Munitions of War Acts, 1915 and 1916. This regulation applies to all aliens working in munition factories, whether as ordinary workmen or voluntary or week-end workers, and the attention of employers is called to the fact that they must satisfy themselves as regards voluntary or week-end workers that all such persons are either British subjects or have obtained from the Ministry of Munitions a permit to work on munitions. The restriction applies to all classes of volunteers, whether National Service Volunteers or volunteers whose employment is arranged for by a local agency.

As briefly announced elsewhere in this issue, Wolstanton, Limited, was registered as a private company on April 17, with a capital of £200.000 in £1 shares (100,000 "A" and 100,000 "B"). The company is to carry on the business of iron and steel makers, and adopt an agreement with the Lilleshall Company, Limited, and the Partington Steel and Iron Company, Limited. The subscribers (each with one share) are: Mr. W. Perrott, Faintree Hall, near Bridgnorth, Salop, director, and Sir John Harmood-Banner, Warrington, director. While the Lilleshall Company holds any "A" shares none of such shares are to be issued to any person except that company or its nominee without its consent. A similar provision applies to the Partington Steel and Iron Company and the "B" shares. No "A" shares are to be issued at any time without a "B" share being offered to the Partington Steel and Iron Company on the same terms, and vice versa. The first directors are Mr. W. Perrott and Mr. J. F. Wright ("A" directors) and Sir John Harmood-Banner and Mr. F. W. Cooper ("B" directors). The registered office is at 22, Billiter Street, E.C.

In the House of Commons last month Dr. Macnamara, answering Colonel Claude Lowther, said:—The functions of the Board of Invention and Research are:—(a) To concentrate expert scientific inquiry on certain definite problems, the solution of which is of importance to the Naval Service; (b) to encourage research in directions in which it is probable that results of value to the Navy may be obtained by organised scientific effort; (c) to consider schemes or suggestions put forward by inventors and other members of the general public. The Board considers all inventions relating to naval warfare and acts in an advisory capacity to the Admiralty. It has funds at its disposal for carrying out trials and experiments and possesses full facilities for arriving at a decision whether an invention is worthy of adoption or not; but the adoption of an invention is subject to the approval of the Board of Admiralty. The general superintendence of the Board of Invention and Research is reserved to the First Lord, to whom it has direct access. The Central Committee meets once a week; the panel once every six weeks; and the sub-committee hold meetings at frequent intervals as the circumstances require.

The question of providing and equipping a technical college for Walsall and district was discussed at a meeting of Walsall and District Chamber of Commerce recently, Mr. W. M. Brookes presiding. Mr. F. E. Thompson (principal of the Municipal Institute), in advocating the proposal, said the war had brought home to this country the necessity of the application of science to industry, and people now realised that this was where we had been lacking in the past. It had, for instance, been said that the English chemist was not so good as the German chemist; that statement was equally ridiculous, but when in Germany they had had forty times as many chemists as there were in this country they were bound to get better work and more research. It was probable that if this country had had an equal number of chemists as Germany, and had been equally forward in scientific invention, the war would have been ended now. If Walsall wished to go ahead it had to look for its industrial expansion in other directions, and the industry which the town should particularly try to foster was that of engineering. It was stated that the scheme was to be considered at a conference of the authorities and bodies interested, and the Chamber accordingly deferred passing any resolution with regard to it, but it was agreed to urge the manufacturers of the town and district to send their apprentices and learners to day classes at the Municipal Institute, whenever practicable, and that clauses providing for this should be inserted in apprenticeship deeds.

## Technical Committee of the Motor Industries.

A new committee, to be known as the Technical Committee of the Motor Industries has been formed by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders in order to co-ordinate the many technical questions which arise in connection with the automobile industry and which have been handled independently in the past. For instance, the Institution of Automobile Engineers formed a Steel Committee over two years ago for the purpose of standardising steels for use on automobiles, and they are also represented on many of the automobile sub-committees of the Engineering Standards Committee. The Society of Motor Manufacturers and Traders have at the same time been represented on those sub-committees, while various other technical matters have been dealt with by their Standardisation Technical and Research Committee which has existed for some time.

Matters have now been put on a better footing, and a joint permanent committee has been formed by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders which will be known by the above title. Invitations to be represented on the Committee have already been accepted by the following:—National Physical Laboratory, Dr. Stanton: General Post Office, Capt. Wheeler: Institution of Mechanical Engineers, Dr. Hele Shaw; Iron and Steel Institute, Mr. J. H. Dickenson; Commercial Motor Users' Association, Mr. Geo. Watson.

The Technical Committee will take over the work hitherto carried on by the Standardisation, Technical and Research Committee of the Society of Motor Manufacturers and Traders, the Steels Committee and the Standardisation Committee of the Institution, and the Research Committee which is carrying out research on the E.S.C. British Standard Steels for automobiles, with the addition of aircraft steels, and which is financed by a Government Grant of £1.000 and a donation of £1.000 from the Society of Motor Manufacturers and Traders and the trade generally.

## Personal.

THE gross value of the estate of the late Mr. P. Fisher, engineer, Arbroath, is £40,008.

MR. W. R. BOUSFIELD has been appointed a member of the Advisory Panel of the Munitions Inventions Department.

THE late Mr. John Kidner, of Kettering, managing director of the Islip Iron Company, Limited, left estate valued at £121,972 gross.

MR. W. MAIR, of the North British Iron Works, Coatbridge, has been appointed manager of the Coats and Phœnix Iron Works, Coatbridge.

THE late Mr. W. Allday, managing director of Alldays & Onions Pneumatic Engineering Company, Limited, left estate valued at £40,910.

THE late Mr. R. Lawson, a director of the Aluminium Corporation, Limited, left estate of the gross value of £104,264, the net personalty being nil.

THE gross value of the estate of the late Mr. W. B. Broadfoot, a director of John Broadfoot & Sons, Limited, brassfounders, Whiteinch, is £10,451 9s.

THE gross value of the estate of the late Mr. James Gilchrist, managing director of Barclay, Curle & Company, Limited, Whiteinch, Glasgow, is £170,322.

THE John Fritz medal has been awarded to Dr. Henry Marion Howe for his investigations in metallurgy, especially in the metallography of iron and steel.

THE late Colonel Edward Snow Mason, D.L., J.P., a director of Clayton and Shuttleworth, Limited, left an estate of the value of £29,616, the net personalty being £27,705.

MR. HUGH WATERSTON, Coatbridge, has been appointed general manager of the Scottish Iron & Steel Company, Limited, in room of Mr. Jardine, who has resigned.

MR. A. T. WALL has been appointed to the position of naval architect to Cammell, Laird & Company, Limited. Previously Mr. Wall was head of the design department of the company

THE value of the personal estate in the United Kingdom of the late Mr. Archibald Colville, chairman of David Colville & Sons, Limited, Dalzell Steel and Iron Works, is £292,025.

MR. J. E. HURST, until recently research metallurgist with Messrs. Rich, Hornsby & Sons, Stockport, has now been appointed chief metallurgical chemist to Messrs. D. Napier & Sons, Acton, London.

MR. H. F. HEATH, chief of the Universities Department at the Board of Education, is to be the head of the new Science and Industrial Research Branch provided for in this year's Education Estimates.

SEC.-LIEUT. CUTHBERT TURNER is reported missing. Before the war he was with Messrs. Hughes, Bolckow & Company, Derwenthaugh, Newcastle, and is a son of Mr. C. Turner, of the Consett Iron Company, Limited.

MR. D. F. HARDIE, of Messrs. Swinburne & Hardie, engineers, Milburn House, Newcastle-on-Tyne, who joined the A.S.C. last year, has been granted a commission in the Mechanical Transport Section, and is in charge of a workshop.

LIEUT.-COLONEL E. W. ALLEN, A.S.C., has been appointed Director of Machinery and Implements in the Food Production Department, in place of Mr. P. D. D. Perry, who has been transferred to the Ministry of Munitions to supervise the manufacture of agricultural machinery required by the Department.

THE late Sir Charles Holcroft, Bart., has bequeathed to the University of Birmingham £5,000 upon trust, to apply the income thereof for the promotion and encouragement of research work in connection with any of the following subjects :—Chemistry, physics, zoology, botany, geology, engineering, mining, and metallurgy.

MR. W. J. WILLIS has resigned the management of the Willingsworth Iron Company, Limited, Wednesbury, to take up the management of the Carnforth Hematite Iron Company, Limited. The position rendered vacant at the Willingsworth Iron Company has been offered to, and accepted by, Mr. T. J. Munnoch, of the Birchills Furnaces, Limited, Wallsall, Staffs.

MR. D. L. COOPER, general manager of the North-Eastern Steel Company, Limited, Middlesbrough, has been awarded a second medal for military valour by the Italian Government for distinguished conduct in removing the wounded from a dressing station under heavy enemy fire on September 3, 1916. The first decoration, it will be remembered, was awarded for bravery during an enemy attack in March, 1916.

THE late Mr. J. Forrest, at one time secretary of the Institution of Civil Engineers, left estate valued at £13,688 gross. The testator left to the Institution a number of testimonials presented to him by Past-Presidents and others, which he asked the council to have exhibited every year on the occasion of the "James Forrest" lectures. He also left £500 to be added to the "James Forrest Lecture Trust Fund."

## Applications for Patents.

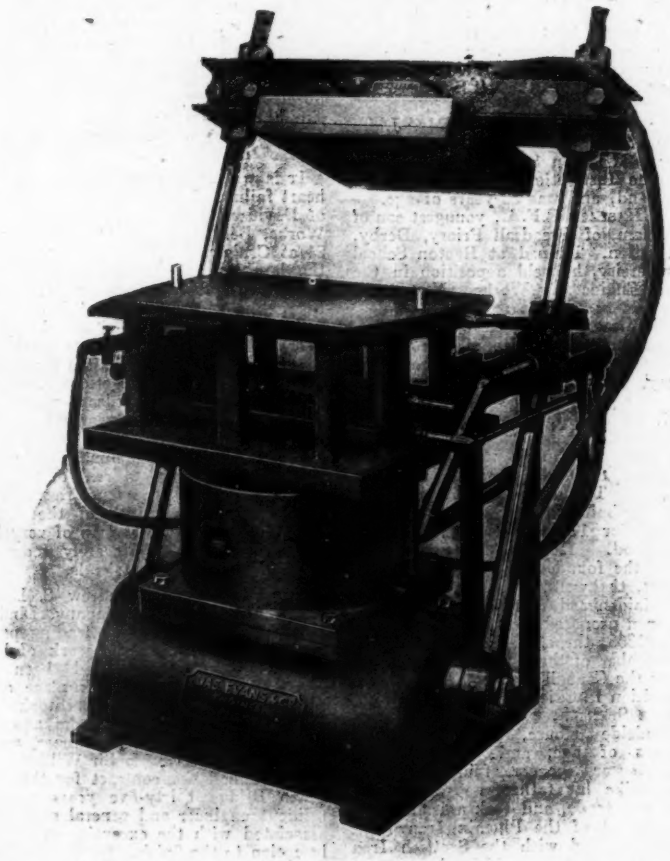
*The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.*

Allbut, J. E. H. Die-casting machines. 5,620. April 21.
Brayshaw, E. R., S. N., and Yates, H. J. Gas-burners for metallurgical, etc., furnaces. 6,567. May 9.
British Thomson-Houston Company (*General Electric Company*). Metals and their manufacture. 5,400. April 17.
Brockfield, D., and Gaunt, J. Furnace for smelting and refining aluminium swarf, etc. 6,592. May 9.
Cusquel, A., and Goupil, H. Devices for pulverisation of molten or liquid metals. 6111. April 30.
Cusquel, A., and Goupil, H. Devices for pulverisation of molten or liquid metals. 5,782. April 24. (France, May 1, 1916.)
Dowson & Mason Gas Plant Company. Gas-heated annealing, etc., furnaces. 6,351. May 4.
Dowson & Mason Gas Plant Company. Air or gas reversing, etc., butterfly valves. 6,352. May 4.
Dowson & Mason Gas Plant Company. Doors of gas-heated annealing, etc., furnaces. 6,353. May 4.
Field, C. H., Gershon, S., and Welford, R. Manufacture of aluminium and collateral products. 6,718. May 11.
Foster, W. J. Superheated air blast for furnaces. 5,703. April 24.
Foster, W. J. Superheated air blast for furnaces, and production of same. 5,704. April 24.
Gallon, J. Distilling and condensing apparatus for gases or other volatile vapours. 6,281. May 3.
Hadfield, Sir R. A. Manufacture of steel. 6,038. April 28.
Hadfield, Sir R. A. Manganese steel. 6,272. May 3.
Hadfield, Sir R. A., Gordon, F. F., and Wilson, A. K. Manufacture of steel. 5,262. April 13.
Hall, I. Melting-furnaces. 5,216. April 13.
Imperial Trust for the Encouragement of Scientific Industrial Research, and Smith, D. Heat treatment of steels. 5,353. April 16.
Ionides, A. C. Gaseous-fuel furnaces. 5,352. April 16.
Ionides, A. C. Melting-furnaces. 5,980. April 27.
Lee, T. Foundry moulding. 6,135. May 1.
Maconochie, H., and Ros, D. de. Melting, oxidising, or volatilising metals, etc. 5,694. April 23.
Manchester Furnaces, Limited, and Russell, W. A. Furnaces for heat treatment of metals. 5,570. April 20.
Mate, W. C. A., and Poulson, A. Production of malleable cast iron. 5,962. April 27.
Mate, W. C. A., and Poulson, A. Treatment of moulds for making metal castings. 5,963. April 27.
Moffat, D. Gas-producers. 6,485. May 7.
Morin, G. Boyelle-. Testing or determining hardness of metal, etc. 5,781. April 24. (France, April 25, 1916.)
O'Donnell, J. P. Oil-burning, etc., furnaces. 6,157. May 1.
Palyitch, D. Filling moulds, etc., with molten substances. 6,371 May 4
Quain, J. R. Electric furnaces. 6,732. May 11.
Richmond Gas Stove & Meter Company, and Hartley, H. Furnaces of the crucible, etc., type. 5,336. April 16.
Soc. Industrielle des Métaux de Synthese. Manufacture of tools from scrap of high-speed or special steels. 6,156. May 1. (France, December 30, '16.)
Stott, O. Heat treatment of metals. 4,975. April 10.
Strettles, S. Foundry moulding. 6,135. May 1.

# MOULDING MACHINES

## OF EVERY DESCRIPTION.

**Pneumatic, Hydraulic, Jar Ramming, & Hand Power.**



**JAMES EVANS & CO., BRITANNIA WORKS,**

**BLACKFRIARS, MANCHESTER.**

## Deaths.

THE death is reported of Mr. J. Mills, shipbuilder, of Barrow.

MR. B. H. BLYTH, of Messrs. Blyth & Blyth, civil engineers, Edinburgh, died on Sunday at North Berwick.

MR. JOHN CORFIELD, general manager of Dillwyn & Company, Limited, spelter manufacturers, Swansea, died recently at his residence, Richmond Road, Swansea.

MR. THOMAS KENNEDY, formerly managing director of Glenfield & Kennedy, Limited, engineers, etc., Low Glencairn Street, Kilmarnock, died on April 20, aged 79 years.

LIEUT. ROBERT GIBSON HUNTER, who was killed in action in France on April 23, was the youngest son of Mr. Robert Hunter, Kirkmailing, Larbert, of Walker, Hunter & Company, Limited, ironfounders, Port Downie, Falkirk.

CAPTAIN A. N. DRYSDALE, M.C., died on April 15, at a casualty clearing station in France, from wounds received in action. He was a director of Drysdale & Company, Limited, engineers, of the "Bon-Accord" Works, Yoker, Glasgow, W.

THE death has occurred at Glasgow of Mr. J. T. Butters, of the firm of Messrs. Butters Bros. & Company, crane builders, M'Lellan Street. Mr. Butters was a member of the Institution of Engineers and Shipbuilders in Scotland, and was 38 years of age.

CAPTAIN W. K. S. HASLAM, R.F.A., youngest son of Sir Alfred Seale Haslam, of Breadsall Priory, Derby, has been killed in action. Trained at Repton School and Cambridge University, he held a position in the Haslam Foundry and Engineering Works. He was 24 years of age.

MR. E. JORDAN, late manager of the Junction Dry Dock, Cardiff, died at his residence at Cardiff, on Sunday, aged 69 years. In early life he was engaged at the Isca Foundry, Newport, and the Tubal Cain Foundry, Cardiff. He prepared the designs for the Junction Dry Dock at Cardiff, of which he became engineer, and subsequently manager.

THE death took place on Sunday at his residence, Sea View, Ryhope Road, Sunderland, of Mr. J. Short, at the age of 59 years. The deceased gentleman was very well known in shipbuilding circles on the North-East Coast, and was for 17 years the chairman of Short Brothers, Limited. He was the son of Mr. George Short, one of the founders of the yard.

MR. GEORGE QUICK, the well-known naval engineer, died on May 20, at Maidenhead, at the age of 75 years. The deceased gentleman proposed, among other things, to the Admiralty in 1866, the steel-facing of armour-plates. He was a member of the United States Naval Institute, and also of the Council of Naval Engineering at the World's Exposition in Chicago in 1893.

MR. J. W. ARTHUR SPENCER, who died suddenly at his residence, Woodside House, Coatbridge, last month, was 46 years of age, and was the only son of the late Treasurer Spencer, founder of the Phœnix Ironworks. Like his father, he was closely associated with the iron trade, and took a leading interest in the management of the Phœnix Ironworks, Coatbridge, now incorporated with the Scottish Iron and Steel Company, Limited, of which he was a director.

LIEUT. G. D. MACLELLAN, killed in action, was the youngest son of Mr. G. S. MacLellan, West Lodge, Dowan Hill, Glasgow. After serving his apprenticeship he graduated B.Sc. in Engineering Science at Glasgow University, and was employed on the staff of P. & W. MacLellan, Limited, Clutha Works, Glasgow. He had just returned from India when war was declared, and he joined the H.L.I., in which he obtained a commission. Subsequently he held a staff appointment under the Ministry of Munitions for about nine months, when he rejoined his battalion.

SIR HENRY ARTHUR WIGGIN, BART., died suddenly last month at his residence, Walton Hall, Eccleshall, Staffordshire, at the age of 65 years. The deceased baronet, who was the eldest son of the late Sir Henry Wiggin, of Harborne, was educated at King's College School, London, and at M. Sellig's school at Vevey, Switzerland. On leaving Switzerland he was sent to the Royal Mining Academy, Freiberg, Saxony. Subsequently he went to the Royal School of Mines in London, where he studied metallurgy under Dr. Percy. In 1871 he entered his father's firm of Henry Wiggin & Company, metal refiners, George Street, Birmingham, and four years later was taken into partnership. When the business was converted into a private limited company in 1892 he became managing director.

THE death is announced of Mr. B. F. Smith, son of Mr. F. R. Smith, of Parkinson and W. & B. Cowan, Limited. After completing his education, he became assistant to his father in the engineering department of the company's works. He served for 12 months in the Army, but was invalided out as the result of an operation, from the effects of which he never recovered.

WE regret to announce the death of Sir Alexander Binnie, who, as chief engineer to the London County Council, was responsible for the construction of the Blackwall Tunnel. He was 78 years of age. Sir Alexander Richardson Binnie was born in London, on March 26, 1839. He went from school to become the pupil, and later, the assistant of the late Mr. J. F. Le Trobe Bateman, F.R.S., the distinguished engineer, whom he succeeded in course of years in the presidency of the Institution of Civil Engineers.

IT is with regret we have to record the death from heart failure of Mr. George G. Ward, deputy chairman of Davidson & Company, Limited, Sirocco Engineering Works, Belfast, which took place suddenly on April 24 at Craigavad. He was the eldest surviving son of the late Mr. F. D. Ward, and began his business career with the well-known firm of Marcus Ward & Company, where he served his time, and eventually held a prominent position He joined the Sirocco Works 21 years ago and was elected a director when the company became a limited concern in 1898. A good business man, an energetic worker, he loyally supported Mr. S. C. Davidson, whose lifelong friend he was, during the many years of their close association and contributed in no small measure to the success of the firm, not sparing himself in any way, and more especially since the outbreak of war, when the absence of two co-directors at the Front greatly increased the work and responsibility of the remaining directors. Mr. Ward was a genial man of very kindly disposition, whose loss will be sincerely mourned by his many personal and business friends.

THE death of Mr. Andrew S. Biggart, chairman of Sir William Arrol & Company, Limited, Glasgow, has removed one who took a leading part under the late Sir William Arrol in the work of building the Forth Bridge. Mr. Biggart had been ill for about two months, and his death took place on April 26 at his residence, Inchgarvie, Sherbrooke Avenue, Pollokshields. Born fifty-nine years ago, Mr. Biggart was trained as a mechanical engineer, and entered the service of Mr. (afterwards Sir William) Arrol. When the firm obtained the contract for the construction of the Forth Bridge thirty-five years ago, Mr. Biggart, as resident engineer and general manager, was intimately associated with the execution of the contract from its inception to the finish. On the successful completion of the great undertaking, Mr. Biggart was assumed a partner of the firm, and he had taken a prominent part in carrying out many important bridge-building and kindred contracts throughout the country. When the firm was converted into a limited liability concern in 1893, Mr. Biggart became a director, and on the death of Sir William Arrol a few years ago he succeeded to the chairmanship of the board. He was a governor of the Royal Technical College, Glasgow, and convener of the Engineering Committee, president of the Glasgow University Engineering Society, a member of the Institution of Engineers and Shipbuilders in Scotland, and of the Institution of Civil Engineers. As representing his firm he took an active part in the work of the Engineering Employers' Federation and the North-West Engineering Trades Employers' Association, and he served for a term as president of the latter body.

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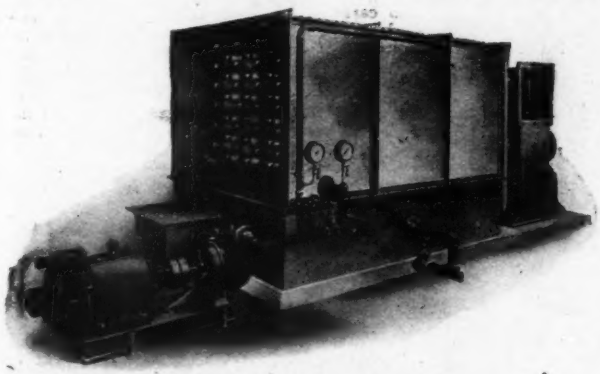

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**Brands:**

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## Legal.

### German High-Speed Steel.

The motion by Stahlwerk Becker Aktiengesellschaft, of Krefeld Willich, Germany, for leave to proceed before the Controller of Patents with an application to amend their specification for a patent, granted in 1912, for high-speed tool steel, again came before Mr. Justice Sargant, in the Chancery Division, recently. In connection with the matter, a petition is pending by Arthur Balfour & Company, Limited, for the revocation of the patent. A discussion took place upon a preliminary point whether an alien enemy was entitled to avail himself of the provisions of Section 22 of the Patents and Licences Act, 1907, which gives a right to a patentee in proceedings for revocation of his patent to apply to amend his specification by way of defence. His Lordship said he had to deal with a preliminary point whether an alien enemy was entitled to avail himself of the provisions of Section 22 of the Patents and Licences Act, 1907. The point appeared to him to be an extremely important one, and he had come to a conclusion different from that which he was disposed to entertain when the matter came before him originally. The question was really this, whether what the German company were proposing to do was by way of defence to the proceedings, or whether it was by way of initiative. It was well settled that an alien enemy might in any proceedings set up a set-off by way of diminution of the claim of a plaintiff, that set-off being a defence. On the other hand, an alien enemy could not counter-claim. Was this application to disclaim a merely defensive application, or was it to any considerable extent an affirmative application? The way in which the section was framed did appear to point to this, that it was a defence given to a respondent in a particular proceeding against him for revocation. What had impressed him a good deal was that the result of allowing the disclaimer would be to permit the disclaiming person to improve his position, not only against the person bringing the proceedings, but as against all the world, but he thought that danger might be guarded against by the very large powers which were given to the Court as to the terms which might be imposed on those asking leave to disclaim. It would be quite competent to make terms under which an alien enemy allowed to disclaim should be precluded from bringing any action after the termination of the war in respect of any breaches of an invention committed during the war. He thought the application, as brought by an alien enemy, ought to be allowed.

### Mackereth v. Lawton.

In the Sheffield County Court, on May 10, Judge Denman Benson delivered judgment in the case of Mackereth & Company, Limited v. Lawton Bros. The plaintiffs sued the defendants for £54 5s. 8d. in respect of hardening 1,030 high-speed steel cutters. There was a counter-claim for £60, the cost of annealing the cutters, which were alleged to be defective. His Honour said this was a case in which plaintiffs claimed £54 5s. 8d., the agreed price of labour for certain hardening of steel tools. The usual method of hardening was to heat the whole of the tool. Plaintiffs suggested a new method whereby only about ⅛ inch of the tool on the cutting edge was heated. Defendants agreed to this method, subject to a test. The tests were not satisfactory and the tools were all rejected by the Ministry of Munitions inspector. The cause of the rejection was that they were insufficiently hardened. The tools were no good to the defendants, and the work had not been done in a reasonable and workmanlike manner. He therefore gave judgment for the defendants. On the counter-claim he found that some of the tools were usable after being rehardened. He therefore found for the defendants for a sum of £30 and costs.

## New Companies.

**Special Steel Company, Limited.**—Capital £50,000 £1 shares.

**Modern Electric Welding Company, Limited.**—Capital £5,000 in £1 shares.

**H. Jessop & Sons, Limited.**—Capital £10,000 in £1 shares, to carry on the business of general foundry suppliers.

**A. J. McNaught & Company, Limited.** — Capital £3,000 in £1 shares, to carry on the business of engineers, etc.

**J. W. Caparn, Limited.**—Capital £10,000 in £1 shares, to carry on the business of malleable and general ironfounders.

**John Chorley & Son, Limited.**—Capital £1,300 in £1 shares, to carry on the business of engineers, etc. Registered office : 53, Conybere Street, Birmingham.

**Wolstanton, Limited.**—Capital £200,000 in £1 shares (100,000 "A" and 100,000 "B"), to carry on the business of ironmasters. Registered office :—22, Billiter Street, E.C.

**Midland Metals (Wolverhampton), Limited.**—Capital £2,600 in 1 shares, to carry on the business of metal smelters and refiners, etc. Registered office :—12, Cherry Street, Birmingham.

**Aabacas Engineering and Supply Company, Limited.** —Capital £2,000 in £1 shares, to take over the business carried on at 44, Hamilton Square, Birkenhead. The first director is M. G. Clayton.

**Farringdon Propeller & Engineering Company, Limited.**—Capital £10,000 in £1 shares (500 founders), to adopt an agreement with F. M. T. Lange and J. E. Temple. Registered office :—39, Victoria Street, London, S.W.

**Premier Steel Company, Limited.**—Capital £500 in £1 shares, to carry on the business of steel merchants, etc. The first directors are S. C. Goodwin and I. Hemming. Registered office : Offices of Scottish Steel and File Works, Neepsend Lane, Sheffield.

**Rivers Engineering Company, Limited.**—Capital £5,000 in £1 shares, to take over the business carried on at Cremorne Wharf, Chelsea, S.W., as the Rivers Engineering Company. The first directors are S. W. Cole, M. Kahn, W. Black, and R. O. Williams. Registered office : Cremorne Wharf, Lots Road, Chelsea, S.W.

**Sheffield Twist Drill & Steel Company (France), Limited.**—Capital £4,000 in £1 shares, to take over the branch of the business of merchants of twist and carbon steel, drills, tools and steel carried on by the Sheffield Twist Drill & Steel Company in France. The first directors are H. A. Dormer (chairman) and J. S. Robertson.

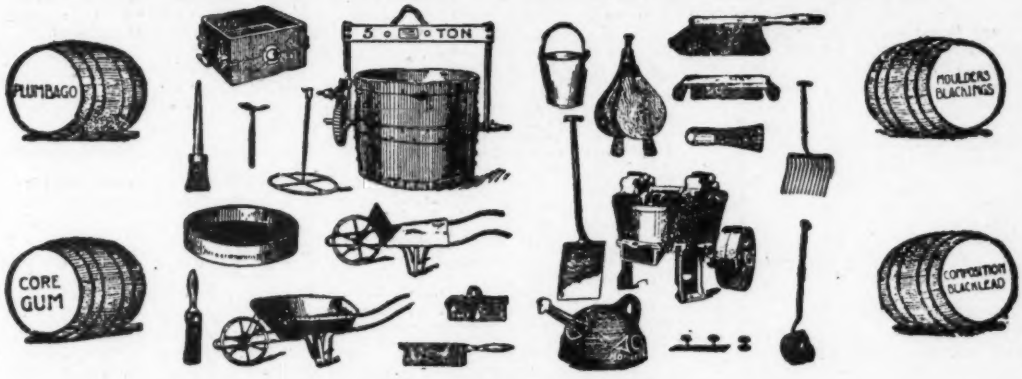
**The National Research Syndicate, Limited.** — Registered with a capital of £50,000 in £1 shares. The objects are to conduct and utilise all kinds of experiments, processes, and manufactures, whether physical, chemical, or otherwise, etc. The subscribers (each with one share) are : H. McGowan, 194, West George Street, Glasgow, director of Nobel's Explosives Company; K. M. Chance, 49, Queen Victoria Street, E.C., managing director of British Cyanides Company; R. G. Perry, chairman of Chance & Hunt, Oldbury, near Birmingham. Nobel's Explosives Company may, while holding 11,000 shares, appoint two directors; Chance & Hunt, while holding 11,000 shares, may appoint two directors; the British Cyanides Company, while holding 3,000 shares, may appoint one director. The last-named company may, within three years, increase its shareholding to an equality with each of the other two companies, and may thereupon appoint an additional director. The first directors are R. G. Perry and C. F. Chance (care Chance & Hunt), K. M. Chance (care British Cyanides Company), H. McGowan (care Nobel's Explosives Company), and W. A. Tennant (9, Mincing Lane, E.C.). The registered office is at 220, Winchester House, London, E.C.

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

*Established 1863.*

# JAS. DURRANS & SONS,

## Phœnix Works, Penistone, Near Sheffield.



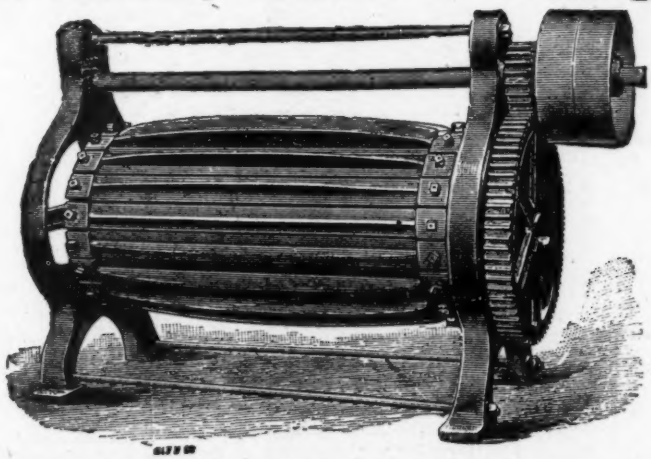

**Manufacturers of all**

## *FOUNDRY EQUIPMENTS*

**COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST**

**Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.**

## Improved Foundry Rattler or Fettling Drum.



**These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.**

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

# MONTHLY PRICE LIST.

**The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.**

## CONTROL PRICES.

These maximum prices of iron, steel and coke were fixed by the Government until June 30, 1916, and thereafter until further notice. Makers may sell for delivery after June 30, on the understanding that the fixed maximum prices ruling on the 1st day of any month during the period of the contract will apply to all deliveries made during that month. This intimation must not be taken to authorise any sale or purchase or other dealing prohibited under the Defence of the Realm Regulations

### Pig-Iron.

| | £ | s. | d. |
|---|---|---|---|
| West Coast hematite, mixed Nos., 1, 2 and 3 .. .. .. | 6 | 7 | 6 |
| Special under 0.03 P. & S... .. | 6 | 15 | 6 |
| „ „ 0.02 „ .. .. | 7 | 0 | 0 |
| East Coast hematite, mixed Nos. 1, 2 and 3 .. .. .. | 6 | 2 | 6 |
| Special under 0.04 P. & S. .. | 6 | 7 | 6 |
| Special under 0.03 P & S. .. | 6 | 15 | 6 |
| „ „ 0.02 „ .. .. | 7 | 0 | 0 |
| Scotch hematite, mixed Nos. 1, 2 and 3.. .. .. .. | 6 | 2 | 6 |
| Special under 0.03 P. & S. .. | 7 | 10 | 0 |
| Welsh hematite, mixed Nos. 1, 2 and 3 .. .. .. .. | 6 | 2 | 6 |
| Special under 0.03 P. & S. .. | 6 | 15 | 6 |
| „ „ 0.02 „ .. .. | 7 | 0 | 0 |
| Lincolnshire, basic or foundry .. | 4 | 12 | 6 |
| Cleveland, No. 1 .. .. .. | 4 | 11 | 6 |
| „ other grades .. .. | 4 | 7 | 6 |
| Northamptonshire, forge .. .. | 4 | 7 | 6 |
| „ fdy. numbers | 89/0 | | 94/0 |
| Derbyshire, forge .. .. .. | 4 | 10 | 0 |
| „ foundry numbers | 92/6 | | 96/6 |
| Derby & Notts. basic. .. .. | 4 | 17 | 6 |
| Leicestershire & Notts., forge .. | 4 | 10 | 0 |
| „ „ foundry nos. | 92/6 | | 96/6 |
| North Staffs, forge .. .. .. | 4 | 15 | 0 |
| „ „ foundry .. .. | 4 | 17 | 6 |
| „ „ basic .. .. .. | 4 | 17 | 6 |
| South Staffordshire— | | | |
| Part mine forge .. .. .. | 4 | 15 | 0 |
| „ foundry .. .. | 4 | 17 | 6 |
| Common Staffordshire .. | 4 | 10 | 0 |
| All mine forge .. .. .. | 5 | 15 | 0 |
| „ foundry .. .. | 6 | 0 | 0 |
| Warm air forge .. .. | 7 | 5 | 0 |
| „ foundry .. .. | 7 | 15 | 0 |
| Lord Dudley's silicon .. .. | 8 | 7 | 6 |
| Cold blast .. .. .. | 9 | 2 | 6 |
| Scotch foundry and forge— | | | |
| Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. .. | 5 | 14 | 0 |
| Nos. 3, 4, and lower grades of all other brands .. .. | 5 | 15 | 6 |

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1½%

### High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows :—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 3s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows :—

| | |
|---|---|
| Millings and Turnings .. .. | 5d |
| Bar Ends .. .. .. | 6d |

Both per lb. net delivered steel makers works.

### Ferro-Alloys

Net, Delivered Sheffield steel works.

| | £ | s. | d. |
|---|---|---|---|
| Ferro chrome : 4/6% carbon. Basis 60%, scale 10s. per unit Per ton | | | |
| Ferro-chrome : 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton | — | | |
| Ferro-chrome : 8/10% carbon. Basis 60% scale, 10s. per unit Per ton | — | | |
| Ferro-chrome : Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton | — | | |
| Ferro-vanadium : 33/40% Va., per lb. of Va. contained in the alloy | — | | |
| Ferro-silicon : 45/50%. Basis 50%, 5s. scale per unit .. Per ton | — | | |
| Ferro-titanium : 23/25%, per lb. carbonless.. .. .. .. | — | | |
| Ferro-molybdenum : 70/80% Mo. per pound of Mo. contained .. | — | | |
| Ferro-phosphorus : 20/25%. Per ton | — | | |
| Ferro-tungsten : 75% to 80% per lb. of metallic tungsten contained | — | | |
| *Ferro-manganese 80% .. .. .. | — | | |
| „ export .. .. | — | | |

* F.o.b. Liverpool.

### Non-Ferrous Metals.

**Copper.**

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Standard, Cash | ..130 | 0 | 0 | 130 | 10 | 0 |
| Three months | ..129 | 10 | 0 | 130 | 0 | 0 |
| Electrolytic .. | ..142 | 0 | 0 | 138 | 0 | 0 |
| Tough .. | ..140 | 0 | 0 | 136 | 0 | 0 |
| Best selected .. | ..140 | 0 | 0 | 136 | 0 | 0 |

**Tin.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Standard, Cash | ..248 | 0 | 0 | 248 | 10 | 0 |
| „ Three months | 246 | 10 | 0 | 247 | 0 | 0 |
| English Ingots .. | — | | | 257 | 0 | 0 |
| Bars .. .. .. | — | | | 258 | 0 | 0 |
| Refined .. .. | — | | | — | | |

**Spelter.**

| | | | | | | |
|---|---|---|---|---|---|---|
| American .. .. | 54 | 0 | 0 | 50 | 0 | 0 |
| Specials.. .. .. | — | | | — | | |
| Hard .. .. .. | — | | | — | | |
| British .. .. .. | — | | | — | | |

**Lead.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Soft Foreign .. .. | 30 | 10 | 0 | 29 | 10 | 0 |
| English .. .. | — | | | Nom. | | |

**Antimony.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Regulus .. .. | — | | | 85 | 0 | 0 |

**Aluminium.**

| | |
|---|---|
| Virgin Metal 98/99% per ton | — |

**Phosphor Bronze.**

| INGOTS. | Per ton. |
|---|---|
| Alloy No. I. or II .. .. | — |
| III., IV. or V. .. .. .. | — |
| VI. or VII. .. .. .. | — |
| VIII. .. .. .. | — |
| XI. .. .. .. | — |
| Cast Strips and Ingots.. .. | — |
| CASTINGS. | Per lb. |
| I. or II. .. .. .. .. | — |
| III. IV. or V. .. .. .. | — |
| VI. or VII .. .. .. | — |
| VIII. .. .. .. .. | — |
| XI. .. .. .. .. | — |
| No. VII., Chill, Cast, Solid .. . | — |
| „ Cored Bars .. .. | — |

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. 35/- above price of best selected copper.

15 per cent. Phosphor Copper .. 40/- above price B.S.

Phosphor Tin (5 per cent.) .. £23 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FARNLEY STREET MILLS, BIRMINGHAM)

***Chromium (Metallic).**

| | |
|---|---|
| 98/99% purity, per lb. | — |

***Nickel.**

| | |
|---|---|
| In cubes, 98/99% purity Per ton | — |

**Nickel Silver.**

| | per lb. |
|---|---|
| Ingots for raising .. .. | — |
| Ingots for Spoons and Forks .. | — |
| „ rolled to spoon size .. | — |

***Tungsten Metal Powder.**

| | |
|---|---|
| 96/98% purity.. per lb. .. | — |

***Molybdenum Metal.**

| | |
|---|---|
| 96/98% purity.. per lb. .. | — |

***Cobalt Metal.**

| | |
|---|---|
| 97% purity .. per lb. .. | — |

**Quicksilver.**

| | |
|---|---|
| 75 lb. bottle .. .. .. | — |

* Net, Delivered Sheffield Works.

### Scrap Iron and Steel.

| | Cleveland. s. | d. | s. | d. |
|---|---|---|---|---|
| Steel scrap, heavy melting.. | 105 | 0 | — | |
| Iron scrap cast (cupola metal) .. .. | 90 | 0 | 95 | 0 |

| | London (f.o.b.). | | | |
|---|---|---|---|---|
| Heavy steel .. .. .. | | | 100 | 0 |
| Light „ .. .. .. | | | 55 | 0 |
| Heavy cast .. .. .. .. | | | 95 | 0 |

**Control Prices.**

| | | | | |
|---|---|---|---|---|
| Heavy Steel Melting Scrap | 105 | 0 | 125 | 0 |
| Turnings and Borings .. .. | | | 50 | 0 |
| Wrought Iron Scrap .. | 105 | 0 | 125 | 0 |

Per ton delivered Buyers' Works.

### Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations :—

| | A. Joseph. £ | s | d. |
|---|---|---|---|
| Hy. Electrolytic Copper Scrap .. | — | | |
| Hy. Selected Scrap Brass .. | — | | |
| Hy. Tinned Copper Wire .. .. | — | | |
| Best Selected Gunmetal Scrap .. | — | | |
| Re-melted Ingot Lead .. .. | — | | |

### Stocks.

| Metals. | Tons. |
|---|---|
| Copper, Europe and afloat .. .. .. .. | — |
| Tin, London, Holland, U.S.A. and afloat .. .. | 12,973 |

### Coke.

| | Middlesbrough. s. | d. | s. | d. |
|---|---|---|---|---|
| Gas Coke .. .. .. | 31 | 0 | — | |

| | Glasgow. | | | |
|---|---|---|---|---|
| Foundry Coke .. .. | — | | 42 | 0 |
| Furnace Coke .. .. | 30 | 0 | — | |
| Gas Coke .. .. .. | — | | | |

| | London. | | | |
|---|---|---|---|---|
| Welsh or Durham Foundry, d/d London Stations in truck .. .. .. | 45 | 6 | 53 | 0 |
| Ditto, d/d Birmingham Stations .. .. .. | 44 | 0 | 48 | 0 |
| Yorkshire, d/d London Stations, in truck .. .. | 42 | 6 | — | |
| Ditto, d/d Birmingham Stations .. .. .. | 39 | 6 | — | |

## CONTROL PRICES OF COKE.

| | s. | d. |
|---|---|---|
| Durham and Northumberland blast furnace .. .. | 28 | 6 |
| „ foundry .. .. .. | 30 | 6 |
| South Yorkshire, West Yorkshire, Lancashire, Staffordshire and Midland Counties blast furnace | 25 | 6 |
| South Wales blast furnace .. | 30 | 0 |
| „ foundry .. .. | 43 | 6 |

All per ton net. f.o.t. ovens.

## SITUATIONS VACANT AND WANTED.

MOULDERS AND CUPOLA MEN WANTED, used to loam and other work, for Class "A" Government work.—MONOMETER MANUFACTURING CO., LTD., Aston, Birmingham.

REQUIRED, MANAGER for Steel Foundry in South of England. Must have good knowledge of Chemistry, and be thoroughly conversant with latest foundry practice. Liberal salary to first-class man.—Write, Box 8463, c/o A. J. WILSON & Co., LTD., 154, Clerkenwell Road, London, E.C.1.

REQUIRED for Brass Foundry in London engaged on Government work, Foreman Moulder with knowledge of moulding machine driven by electric motor; also a Core Maker. Must be ineligible.—Write full particulars to Box 880, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.2.

FOUNDRY MANAGER, age 44, at present holding responsible position in the Colonies, is willing to return to England to take up a similar position, or to assist in munition work. Used to the production of heavy castings, to varied specifications, and to shops employing 80 to 100 moulders, etc. Expert in moulding machine work, and in reclaiming sands, etc.— Address Box 876, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C. 2.

## FOR SALE AND WANTED.

CUPOLA, 23 ft. by 3 ft. 6 in., latest type, with air belt and drop bottom, suitable for melting from 3 to 4 tons per hour.—STEEL WORKERS, LTD., Charles Henry Street, Birmingham.

A FIFTY CWT. Geared Second-hand LADLE for Foundry, in good condition. Price £10 10s.—Address Box 878, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.2.

SMITH'S Hearths, Forges, Power and Hand Blowers, Swage Blocks, Anvils, Vices, etc.—DANDRIDGE, Norman Road, Greenwich, London, S.E.

FOR SALE.—24-in. Invincible Sand Mixer, capacity 3 tons per hour, for grinding, mixing and screening foundry sands, at lowest cost per ton.—Apply HALL, 26, Paradise Square, Sheffield.

BELT-DRIVEN Fan, 34 in., by Musgrave, overall of casting 5 ft. 3 in. long by 3 ft. 2 in. by 4 ft. 3 in. high, 26 in. outlet.—C. F. DAVIS, 22, Billiter Street, London, E.C.3.

ONE very strongly-built W.I. Steam Box, about 11 ft long by about 20 ft. wide by 12 in. deep, fitted with internal steam pipes and three W.I. lids for steaming timber. 40-Ton Steel Metal Ladle, 8 ft. 6 in. dia., 8 ft. deep, firebrick lining, lifting shackles, etc., on portable railway, truck 4-ft. 8½ in. gauge, spare ladle and chains.—RICHARD SIZER, LTD., Cornwall Street, Wilmington, Hull.

## FOR SALE AND WANTED.—*cont.*

ONE Engine-driven Roots' Blower, No. 3 size, 10 in. outlets, iron revolvers, direct coupled Inverted Vertical Engines; done very little work. — THOMAS MITCHELL & SONS, LTD., Bolton.

40-TON STEEL METAL LADLE, 8 ft. 6 in. dia 8 ft deep, firebrick lining, lifting shackles, etc., on portable railway, truck 4 ft. 8½ in. gauge, spare ladle and chains.—RICHARD SIZER, LTD., Cornwall Street, Wilmington, Hull.

BLOWING FAN, by Alldays, 12 in. outlet; EXHAUST FAN, cast-iron casing, 10 in. outlet and inlet, F. and L. pulleys; BAKER'S BLOWER, 6 in. outlet; 30 in. New Belt-driven VENTILATING FAN, cheap.—PARKER, Siddals, Derby.

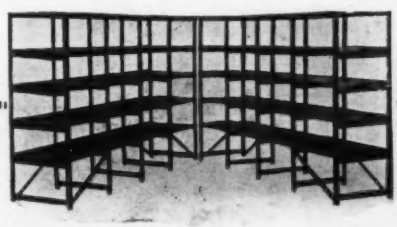
FANS AND BLOWERS.—Enquire from our rebuilt Fan Dept. for your needs before placing order elsewhere.

State clearly the volume and pressure, with brief description of working conditions.

We are always open to purchase approved makes of Propeller and Centrifugal Fans.

PROGRESSIVE ENGINEERING CO., LTD., LEICESTER.

**F. L. HUNT & CO.,**
FOUNDRY
FURNISHERS
AND
FOUNDRY REQUISITES
Of every description.
**56, 58, 60, CHAPEL STREET, SALFORD, MANCHESTER.**



**SANKEY**
**Fireproof Steel Storage Bins**
**For Workshop and Warehouse**
*Write for Details.*
**Joseph Sankey & Sons, Ltd.,**
**Hadley Castle Works, WELLINGTON, Shropshire.**

PLUMBAGO—CRUCIBLES.

Parting Powder.

**WILLIAM OLSEN, LTD.,**
**Cogan Street, HULL.**

**FOUNDRY MATERIALS AND REQUISITES.**

Largest Stock of Straw and Wood Fibre CORE ROPINGS.

Wax Core Vent.

GLUTRIN—CORE GUM.

**FIRE BRICKS & CLAY**
**CUPOLA BRICKS.**
*Best Quality.*

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

**KING BROTHERS,**
(STOURBRIDGE) Ltd.,
**STOURBRIDGE.**

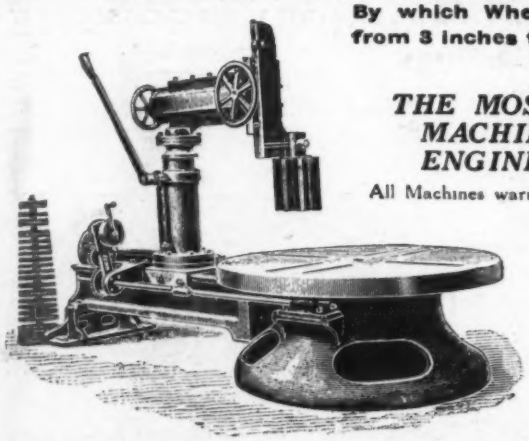
38½
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips: also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL, LTD.
KINNING PARK IRONWORKS,
GLASGOW
36"
32½"

**CAN ALSO BE MADE IN ALUMINIUM.**

Kindly mention this paper when enquiring or ordering.

**WHITTAKER'S IMPROVED MOULDING MACHINE**

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made,



*THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.*

All Machines warranted to Mould with the greatest accuracy and precision.

**GEARING WHEELS**

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

**ROPE & BELT PULLEYS.**

**WM. WHITTAKER & SONS, LTD.,**

*SUN IRON WORKS,* *OLDHAM.*

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**Addresses, Telegraphic Addresses, and Telephone Numbers.**

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| 343 | Alldays & Onions, Ltd. | Birmingham | Alldays, Birmingham | 28 Victoria |
| 345 | Anglo-Mexican Petroleum Co., Ltd. | Finsbury Court, Finsbury Pavement, E.C. | Mexproduct, Ave, London | City 2704 |
| 340 | Baldwin (Aston) Ltd., J. & W. | Aston, Birmingham | "Splinters" Birmingham | 254-5 East. |
| 345 | Braby, F. & Co., Ltd. | Petershill Road, Glasgow | Braby, Glasgow | — |
| 337 | Bradley, T. & I. & Sons, Ltd. | Darlaston | Bradley, Darlaston | — |
| | Britannia Foundry Co. | Coventry | Stoves, Coventry | 251 |
| | British Binderit Co., Ltd. | Wharf Road, Wandsworth, S.W. | Bindercomp, Wands., London | 994 Putney |
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| 347 | Broadbent, T. & Sons | Huddersfield | Broadbent | 1581 (4 lines) |
| C.iv. | Buckley & Taylor, Ltd. | Castle Iron Works, Oldham | Engines, Oldham | Oldham No. 8 |
| 346 | Cumming, William & Co., Ltd. | Maryhill, Glasgow | Prudence, Glasgow | P.O.M. 25 |
| 337 | Davidson & Co., Ltd. | Belfast | Sirocco, Belfast | 4341 Belfast |
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| 344 | Everitt & Co. | 40, Chapel Street, Liverpool | Persistent, Liverpool | 1134 Central (3 lines) |
| 344 | Fyfe, J. R., & Co. | Shipley, Yorks | Brick, Shipley | 59 Shipley |
| 340 | Gibbons, James | Wolverhampton | — | — |
| | Glasgow Patent Moulders Blacking Co. | 26, Fleming St., Port Dundas, Glasgow | Moulders, Glasgow | — |
| | Goldendale Iron Co., Ltd. | Tunstall, Stoke-on-Trent | Goldendale, Tunstall, Staffs | — |
| 344 | Hall, John & Co. (Stourbridge), Ltd. | Fire Clay Works, Stourbridge | Hall, Stourbridge | 55 Stourbridge |
| 338 | Hedley Moorwood & Co., Ltd. | 21, Church Street, Sheffield | Morod, Sheffield | 4318 |
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| 392 | King Bros. (Stourbridge), Ltd. | Stourbridge | King Bros., Stourbridge | — |
| | Lawson Walton & Co. | 2, St. Nicholas Bldgs, Newcastle-on-Tyne | | |
| 340 | Lowood, J. Grayson, & Co., Ltd. | Deepcar, nr. Sheffield | Lowood, nr. Sheffield | 18 Stocksbridge |
| C. i. | Macdonald, John, Ltd. | Watt Street, Maryhill, Glasgow. | "Compressor, Glasgow." | 61 Maryhill (N) |
| 347 | Mansergh, T. E. | Wheathill Charcoal Works, Salford | — | — |
| | Metalline Cement Co. | 112, Bath Street, Glasgow | Adhesive, Glasgow | 201Y2 Douglas |
| 392 | McNeil, Chas., Ltd. | Kinning Park, Glasgow | McNeil, Glasgow | X 155 |
| 337 | Monometer Manufacturing Co., Ltd., | Whitehouse St., Aston, Birmingham | — | — |
| 347 | Naish & Croft | 150, Alma Street, Birmingham | — | — |
| 392 | Olsen, William | Cogan Street, Hull | Wm. Olsen, Hull | Nat. 1184 |
| C. iii. | Phillips, J. W. & C. J. | 23, College Hill, E.C. | Colloquial, London | 10112 Central |
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| 346 | Universal Machinery Corporation, Ltd. | 336, Old Street, London, E.C. | Toolcraft, London | 3763 London Wall. |
| 340 | Universal System of Machine Moulding and Machinery Co., Ltd. | 97, Queen Victoria Street, London. E.C. | Machimould, London, | 2243 City |
| 388 | Walker, I. & I. | Rotherham | — | — |
| | Walco, Ltd. | 53, Newton Street, Birmingham | Walco, Birmingham | Central 3305 |
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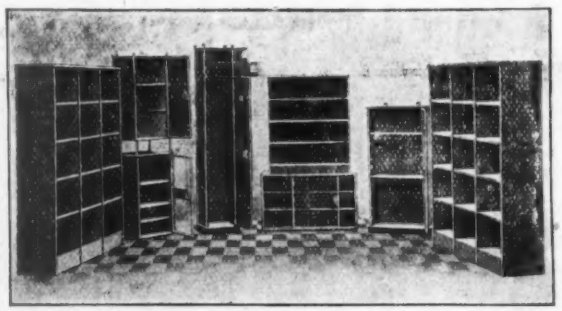

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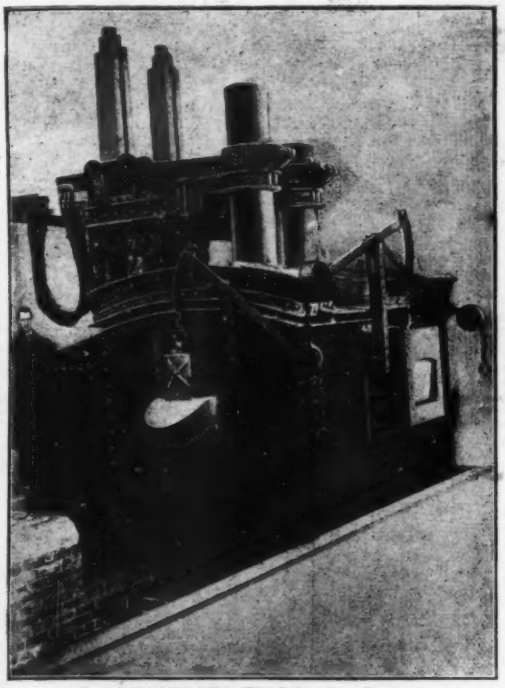

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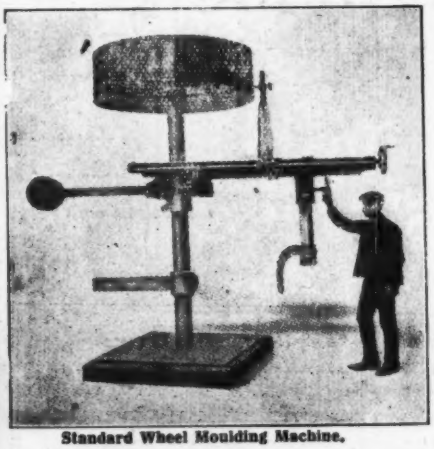

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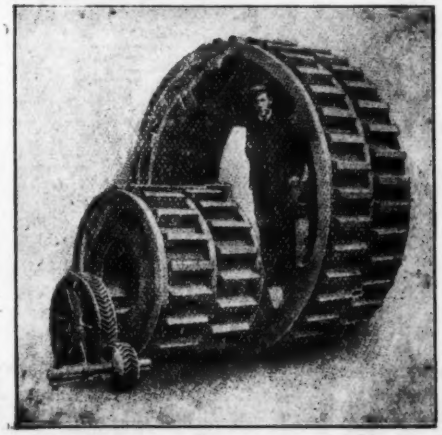

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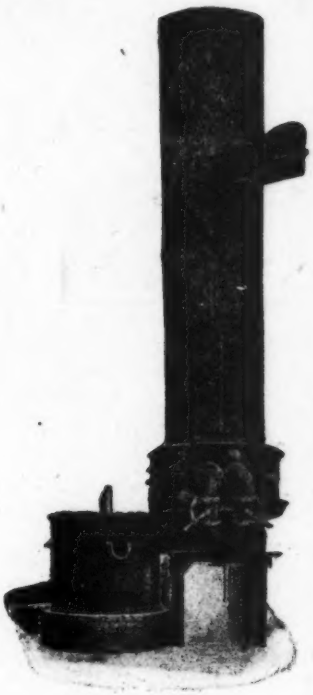

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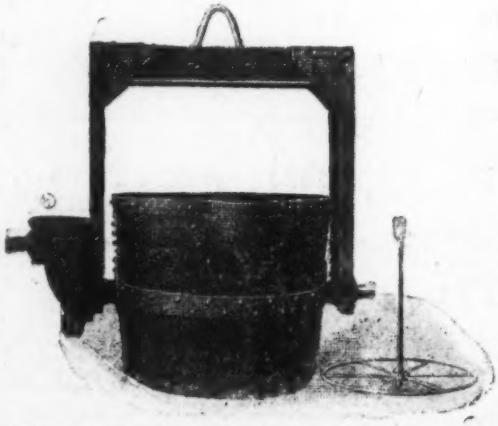

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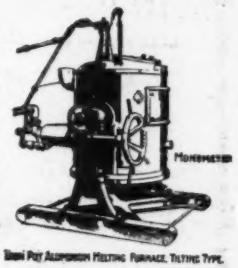

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